Volume VIII
Number 3

MARCH, 1917

$3.00 a Year
35c. Per Copy

The Journal of Educational Psychology

EDITORS

W. C. BAGLEY, C. E. SEASHORE,
J. CARLETON BELL, G. M. WHIPPLE
Managing Editor

PUBLISHED MONTHLY, EXCEPT JULY AND AUGUST, BY
WARWICK & YORK, INC.,
LANCASTER, PA. BALTIMORE, MD.

[Entered as second-class matter at the postoffice at Lancaster, Pa., under the Act of March 3, 1879.]

CONTENTS

ARTHUR S. OTIS. *A Criticism of the Yerkes-Bridges Point Scale, with Alternative Suggestions* 129

HERBERT WOODROW. *Practice and Transference in Normal and Feeble-Minded Children. Part II: Transference* 151

G. C. MYERS. *Confusion in Recall* 166

COMMUNICATIONS AND DISCUSSIONS:

The Pointed Cube Construction Test. (E. A. Doll) 176

EDITORIAL 179

NOTES AND NEWS 182

PUBLICATIONS RECEIVED 186

DRAPER'S SANITARY ROLLER WINDOW SHADE

NOT an adjuster, but a complete adjustable shade. Made from COTTON DUCK, has no filling, will not check nor crack. This shade may be rolled up from the bottom at the same time that it is lowered from the top. We have eliminated the slow and uncertain process of looping, folding, or hooking. This shade will expose all the window without dropping below the window sill. Our rollers are unique, in that they will not run away, because they are provided with a positive stop or locking device that automatically catches the roller by means of a GRAVITY hook the moment the operator releases his hold upon the bottom pull. The shade hangs from an automatic pulley that can be quickly attached to the window cap by the insertion of two screws which completes its hanging.

—•—

Luther O. Draper Shade Company

SPICELAND, INDIANA

VOLUME VIII MARCH, 1917 NUMBER 3

THE JOURNAL OF
EDUCATIONAL PSYCHOLOGY

A CRITICISM OF THE YERKES-BRIDGES POINT SCALE, WITH ALTERNATIVE SUGGESTIONS[1]

ARTHUR S. OTIS[2]
Stanford University

INTRODUCTION

In the Yerkes-Bridges Point Scale the "all-or-none" method of scoring intelligence is replaced by a method which gives partial credit for partial answers presumably in proportion to merit. The avowed purpose of the Point Scale as stated on page 9, is that "It brings out the full value of the test material without increasing the expenditure of time and energy."

The purpose is undoubtedly a laudable one. Certainly, much valuable data are unused by the all-or-none method of scoring. If one child puts the form board together in ten seconds and another takes three minutes to perform the same task, it would seem that there is a difference of intelligence between the two which would be well worth taking account of, and that it is a needless disregard for accuracy to give the same score to each. It is all too difficult to get sufficiently accurate data as it is. It is not urged that more accurate data be necessarily gotten, but that all that is gotten be used if convenient.

In the opinion of the writer, however, the method used in scoring with the Point Scale fails entirely to accomplish the purpose sought. The criticisms that are to be made are of such a nature that it has seemed impractical to attempt to make them without first giving a rather full outline of the requirements of a valid point scale, as conceived by the writer, in the light of

[1] R. M. YERKES, J. W. BRIDGES AND ROSE S. HARDWICK. *A Point Scale for Measuring Mental Ability.* Warwick and York, 1915.

[2] The writer is indebted to Dr. Lewis M. Terman of Stanford University for many helpful suggestion in the preparation of this paper.

which it is believed the criticisms can be made more clearly and easily.[3]

Considerations Regarding the Choice of Units for a Scale of Intelligence

Although the word "intelligence" as employed by Binet was originally used to denote those mental qualities, differences of which differentiated the "feeble-minded" from the "normal," the general assumption underlying the universal use of the Binet Scale is that these are the same mental qualities, differences of which differentiate older normal children from younger. This is the same as saying that children, in maturing mentally, virtually pass through the various stages of intelligence from what would be for adults feeble-mindedness up to normal-mindedness —they mature in intelligence. It has been found, however, that in terms of "mental age" derived from the number of tests passed, children mature in intelligence at different rates. Those who mature rapidly are called "bright," those who mature slowly, "dull." The general conception is also that the yearly increments of intelligence decrease with age, so that intelligence approaches a maximum at a certain age, perhaps not far from 18, and presumably approximately the same for all persons, this being called the "age of maturity of intelligence." Test results suggest that if we had perfect measures of the intelligences of a very large number of children of each age we would find them distributed for each age approximately according to the law of normal distribution; and, as would follow from what was said above, children who are above or below normal (median for their age) have degrees of intelligence comparable to that normal for older or younger children. Children of the same degree of intelligence (mental age) but of different ages may be said to differ in "brightness."

Although originally, no doubt, the word intelligence was intended to apply only to what we have called "brightness," practically every writer on Binet testing has come to use the word, intelligence, also to mean that which is measured by the mental age (of children as well as of adults). Therefore, it has seemed

[3] Since writing this article (April, 1916) the writer has undertaken to make a point scale along the lines indicated. It has seemed advisable, therefore, to omit some mathematical proofs and other detailed considerations which will be given in the description of the completed scale.

necessary to adopt a new term, brightness, to denote that in which children may differ who have the same intelligence—mental age. Brightness would therefore be measured by an intelligence quotient.

Standard 10-year intelligence being generally defined as the median 10-year intelligence, or that degree of intelligence possessed by[4] 50% of unselected 10-year-olds, a child of any age possessing this degree of intelligence is said to have a mental age of 10 years. This method of characterization of an individual's degree of intelligence, however, is not adequate, since by it there is no way of expressing the degree of intelligence which is above that normal for adults.

While it will not be known what exact relation exists between a child's degree of brightness at one age and his degree of brightness at another age until the same children have been tested repeatedly in successive years with very exact tests, it is quite probable, and we shall assume, that degrees of "brightness" are theoretically constant for a given child, being a fixed character of the endowment, so that a child who is really below normal at one age will be so at all ages, and that an adult who is above normal was as much above normal relatively at any stage of development. The indications of data thus far gathered tend to confirm this theory. Its truth is, in fact, the foundation of our hopes in testing intelligence, for if it is not true, in part at least, we can not prognosticate, and intelligence measurement will be of no great value.

In stating that intelligence is assumed to approach a maximum, or maturity at some age, say 18, we are, of course, considering what we might call the *absolute* amount of intelligence, as measured in theoretically equal units, as distinguished from being measured on a year scale. Yearly increments of growth of intelligence are equal, of course, in the sense that years are equal, but not in absolute amount, unless perhaps during childhood.

It is customary among writers to denote the degree of brightness of a child in terms of an "intelligence quotient" (I Q), which is the quotient obtained by dividing the actual mental age of an individual by the mental age normal for his chronological age.

---

[4] The expression "that degree of intelligence possessed by," will be used hereafter to mean "that degree of intelligence which is equalled or exceeded by the degree of intelligence possessed by," etc.

This amounts to dividing by the chronological age in all cases in which the latter is not above the age of maturity of intelligence. Thus a child of 10 having a mental age of 12 has an I Q of 12-10 or 1.20, or an adult of 30 years having a mental age of 15 has an I Q of 15-18 or .80 (assuming 18 years to be the age of maturity of intelligence). This method involves two difficulties; first, by virtue of the above mentioned limitation on the mental age method of expressing degrees of intelligence and second, because an I Q of 15-18 is very probably not equal to an I Q of 5-6 since 15-year mental age is very probably much closer to 18-year mental age relatively than 5-year mental age is to 6-year mental age.

The first of these difficulties has been met by assigning arbitrary mental ages above that of maturity to designate the degrees of intelligence above that normal for the age of maturity. At best, however, this method is objectionable.

Terman and Stern have found, however, by successive testing of the same individuals that I Q's gotten by dividing mental by chronological age do remain fairly constant up to the age of 14, which, if we make the hypothesis that degrees of brightness are constant, would indicate that the yearly increments of intelligence are to be considered as equal absolute units up to about the age of 14.

For the purpose of getting a clear idea of the nature of the intelligence of an abnormal child, it is well to express his degree of intelligence in terms of the normal intelligence for other ages or, in other words, in terms of mental age. Thus, it is very significant to say that a 10-year child has an intelligence which is normal for a child of 7 years or of 13 years, or, as we say, that he has a mental age of 7 years or of 13 years. But on account of the above mentioned defects of this method for purposes of comparison of degrees of brightness of children of different ages, it would seem very desirable, if a 10-year child deviates from the average, to be able to say that he has an intelligence which exceeds that possessed by 65% of 10-year-olds or only 35% of 10-year-olds, etc.

If it may be assumed, as would seem reasonable in the light of facts to date, that if a 10-year child exceeds 65% of 10-year-olds in intelligence, he has exceeded and will exceed 65% of children of his age when at any other age, including adulthood,[5]

[5] The determination of the degree of approximation of this assumption to the truth, as has been said, awaits the testing of the same individuals through successive years.

then this method of expressing the degree of brightness of an individual becomes very convenient for purposes of comparison or prognostication. Thus we may say that a 10-year-old exceeding 65% of 10-year-olds in intelligence is of the same degree of brightness as a 13-year child or as an adult if either of these exceeds the same percentage of persons of his age in intelligence. Also we may say that he is "brighter" than an individual of any age who exceeds a lesser percentage and "duller" than one who exceeds a greater percentage. The maximum ultimate attainments in test performances of any child upon reaching maturity can thus be predicted from his rank at any age and a knowledge of the ability of adults of the same rank.

For reasons which will appear later, it will be found best to deal principally with intelligence as measured on an absolute scale. Since in measuring intelligence we begin by finding the degrees of performance in certain tests which a person may accomplish, and end by stating his mental age or the percentage of persons of his chronological age whom he exceeds in intelligence, it will be seen therefore that an absolute scale of intelligence may be graduated somewhat arbitrarily since it is only a means to an end, upon the attainment of which the arbitrary scale itself is no longer in evidence.

For the purpose of expressing the different absolute degrees of intelligence in tangible units, let us begin with that degree which is normal for adults—that which is possessed by 50% of unselected adults—and call this an absolute intelligence of grade 100. Then assuming the distribution of absolute grades of intelligence to be normal we could represent that grade possessed by 75% of adults as a grade of 90 and that grade possessed by but 25% of adults as a grade of 110. The unit difference in absolute intelligence is thus defined as $^1/_{10}$ of the quartile of the distribution of absolute degrees. According to this definition, the correspondence between the grades of general intelligence denoted by the values 60, 70, etc., representing respectively —4Q (Q = quartile), —3Q, etc., of the distribution, and the percentages of adults which theoretically would possess those values would be as shown in Table I.

TABLE I

Grade of general intelligence.....	60	70	80	90	100	110	120	130	140
Point in the distribution.....	—4Q	—3Q	—2Q	—Q	C.T.	+Q	+2Q	+3Q	+4Q
Percentage of adults possessing these..	99.7	98	91	75	50	25	9	2	0.3

So far we have only defined hypothetical absolute degrees or grades of intelligence in terms of an arbitrary scale. We may be permitted to do this irrespective of what degrees of performance in any test denote the grades of absolute intelligence and irrespective of the percentage of children of any age possessing any absolute grade of intelligence. It is not even essential that the distribution of grades of adult intelligence be normal as measured in any of the natural units such as dollars of earning capacity, or digits remembered, or words in vocabulary or even mental age. The absolute units of intelligence are purely hypothetical and are so defined that the distribution of grades of adult intelligence *will be normal.*

In the sense in which the absolute grades of intelligence possessed by unselected adults fall into a normal distribution, the absolute increments of intelligence composing the units of the absolute scale are equal increments, and in this sense, therefore, an individual possessing the absolute grade of 120 is as much more intelligent than one possessing a grade of 110 as the latter is more intelligent than one possessing a grade of 100, etc. This suggests a more mathematical measure of the degree of brightness.

Thus, to express the degree of brightness of an adult of absolute grade 120 in comparison with the normal adult grade of 100, we might divide 120 by 100 and say the individual had a degree of brightness or *coefficient of brightness* of 1.20. An adult possessing a grade of 110 would therefore have a coefficient of brightness of 1.10, etc. The first is therefore as much brighter than the second as the second is brighter than a normal adult. Such a fact could not be determined when brightness is expressed in terms of percentage rank in intelligence. The coefficient of brightness of a child would then be expressed as the quotient obtained by dividing the absolute grade of intelligence possessed by him by the absolute grade which was normal for children of his age.

Having so made an arbitrary absolute scale of intelligence, however, it would not follow that an individual's coefficient of brightness in these terms would be constant. That is, we do not know that an intelligence grade of 80 in these terms would bear the same proportion to one of 100 that one of 60 would to one of 75, although the first is in each case $^4/_5$ of the second in terms of our arbitrary scale. This is because we do not know

that we have chosen our units so that zero on the scale represents "just not any intelligence" or true absolute zero.

A possible method would be the following if we may assume that the distributions of intelligences of children of any given age, when measured on an absolute scale, are "normal," and that if the units are properly chosen these distributions will have the same coefficients of variation (such coefficient being taken as the quartile value divided by the median). Such an assumption is merely a corollary to the assumption that degrees of brightness are constant for a given individual. The method would then be merely to find the difference between median adult intelligence and true absolute zero, as a multiple of the Q value (quartile distance on the scale) and then to change the number of units in Q from 10 (arbitrarily assigned) to that number which will make the above mentioned difference 100.

Terman[6] has pooled the I Q's of 1000 unselected children and finds them distributed as shown in Table 1A. Here we note that 75% of individuals reach an I Q of .92 while 25% reach 1.08, meaning that the quartile distance on the scale of I Q's is .08 points. The percentages corresponding to the positive and negative multiples of Q are very near the theoretical values to be expected in a normal distribution as may be seen by comparing Tables 1A and 1B. If the yearly increments of intelligence are fairly equal in absolute units up to the age of 14, these data would incline us to believe that the median intelligence of individuals of any given age in true absolute units is not far from 12½ times the quartile distance in the distribution of those values. This would mean that the Q of the distribution of adult intelligences should perhaps be 8 units. If that were the case (which let us suppose for illustration) the percentages of adults possessing the various grades of intelligence by the true absolute scale would be as shown in Table 1B.

TABLE 1A

Showing the Percentages of 1000 Unselected Children Reaching Various Intelligence Quotients, as Found by Terman

Percentages of Children	99	98	97	95	90	85	80	75	66⅔	50
Corresponding I Q's	70	.73	.76	.78	.85	.88	.91	.92	.95	1.00
Percentages of Children	33⅓	25	20	15	10	5	3	2	1	
Corresponding I Q's	1.06	1.08	1.10	1.13	1.16	1.22	1.25	1.28	1.30	

[6] LEWIS M. TERMAN. *The Measurement of Intelligence*, 1916.

TABLE 1B

Showing the Theoretical Percentages of Adults Attaining the Various Absolute Grades of Intelligence, the Quartile Value of the Distribution Being Taken as 8 points with Median at 100

Grades.....	60	62	64	66	68	70	72	74	76	78
Percentages	99.96	99.93	99.88	99.79	99.65	99.43	99.09	98.58	97.85	96.82
Grades.....	80	82	84	86	88	90	92	94	96	98
Percentages	95.41	93.54	91.13	88.11	84.41	80.04	75.00	69.35	63.21	56.70
Grades.....	100	102	104	106	108	110	112	114	116	118
Percentages	50.00	43.30	36.79	30.65	25.00	19.96	15.59	11.89	8.87	6.46
Grades.....	120	122	124	126	128	130	132	134	136	138
Percentages	4.59	3.18	2.15	1.42	0.91	0.57	0.35	0.21	0.12	0.07
Grade.....	140									
Percentage.	0.04									

Considerations Regarding the Selection and Use of Tests

Before we can find the percentages of children of different ages who possess the different absolute grades of intelligence as defined, it will be necessary to have an objective means of determining the grades of intelligence of adults and children. It is this purpose, of course, which "tests" serve. Now the tests may be such as are scored simply as right or wrong and the grade of intelligence indicated by the number of tests "passed" or answered correctly. This constitutes what is called the "all-or-none method" which is used to a large extent in the Binet Scale and which is condemned by Yerkes and Bridges.

Another method is that of defining degrees of performance in a single test and determining the grade of intelligence from the degree of performance achieved. It is this method which is believed by the writer and presumably by Yerkes and Bridges to be superior to the all-or-none method, since, as has been said, the degree of a performance such as the quickness of putting together a form board, is of additional significance to the mere fact of its having been put together and since it is no more trouble appreciably to take the time than not to do so.

It should be noted that the second method is used to some extent also in the Binet scale, in that different degrees of performance are recognized and scored as such in a number of tests, such as the vocabulary, fables, memory for ideas, picture interpretation, etc. These will be considered at length later.

Since it is evident that where different degrees of performance in a test may be easily determined and are believed to be significant, they should be taken into account, let us consider the making of a scale or series of tests for measuring the degrees of each of the various abilities of an individual which are deemed to depend largely on intelligence. For purposes of illustration and comparison with the Yerkes scale we shall confine ourselves to those tests which have been tried out, particularly those which are used in the Binet Scale.

In selecting tests and determining upon the degree of exhaustiveness of each, many considerations should be borne in mind, which we need not discuss. It is probable that some of the lengthy tests of the Binet Scale, such as the fables, code, and vocabulary tests should be either shortened or replaced by others, while some of the short ones, such as the dissected sentence test, could be made to afford a greater variety of degrees of performance. It is probable also that a number of new tests could be added to the Binet list to advantage. For the sake of illustration let us assume that we shall find it advisable to include in our series of tests those in Table II.

TABLE II

Possible List of Tests Used in the Series

1. Vocabulary
2. Completion
3. Opposites
4. Similarities
5. Analogies
6. Logical reasoning
7. Arithmetical reasoning
8. Memory for digits
9. Memory for sentences
10. Memory for ideas
11. Memory for designs
12. Dissected sentences
13. Resourcefulness
14. Fables or proverbs
15. Picture interpretation
16. Formboard
17. Associations
18. Sense discrimination

Considerations Regarding the Combining of the Results of the Tests

Our next task is to combine the measures of ability by the various tests so as to get the best measure of intelligence. This cannot be done, of course, by merely adding together or averaging the scores of the several tests. These must be reduced to a common basis first. One method which might be used would be to equate the averages to the standard or median deviations of the distributions of scores made in the several tests by the same group of individuals. This method would be unsafe, however, until such time as the elements of the several tests

have been very carefully graduated in difficulty so that for any given test the increments of difficulty between the elements are very nearly equal, thus guaranteeing comparability of the distributions of scores in the several tests.

The method advised is, therefore, that the common basis to which to reduce all test scores is the absolute scale of ability. That is, we should find the absolute grade which should be assigned to each degree of performance in each test series. Thus, any degree of performance achieved by 50% of adults would be considered as grade 100 in that test and would be equal to grade 100 in every other test. Degrees of performance in the several tests achieved by 75% of adults would similarly be considered as of grade 90 and therefore equal, etc.

It would be necessary, no doubt, to supplement this method in the cases of the lower degrees of performance by other means since very large percentages of adults would be untrustworthy. Degrees of performance below 80, say, might be equated to one another by finding their relation to an age scale, that is, by finding the degree of performance in each test which may be achieved by 50% of the children of the various ages; or rather, perhaps, to find the age at which just 50% of children could achieve each of the designated degrees of performance in each test. A method which could be employed for this purpose is explained by the writer elsewhere.[7]

Another method, which would probably be more suitable in cases where there are a considerable number of degrees of performance in a single test, would be to find the curve of relation or "*regression curve*"[8] between age and the several degrees of performance, letting ages be the abscissas and finding first the median degrees of performance for each division of the age scale as a basis for drawing the curve. From this curve then, the precise age could be found for which each degree of performance was most probably standard. In this way a series of scales (virtually diminutive Binet Scales) could be made, each complete in itself in a small way.

The question may now arise in the mind of the reader why we do not rest with finding the mental age of the child in each test and determining a representative value of these mental ages.

---

[7] *Some Logical Aspects of the Binet Scale*, Psychological Review, March and May, 1916.

[8] See Wm. Brown, *The Essentials of Mental Measurement*, 1911.

The reasons for converting the test score from mental ages into absolute grades of intelligence or of the specific ability, are as follows: First, it is not correct to average the scores as mental ages in all cases since the absolute average of a mental level of 16 years and one of 12 years is not one of 14 years but is less than 14 years, that is, 16-year ability is, absolutely considered, closer to 14-year ability than is 12-year ability. A second reason is that we cannot express degrees of ability above normal adult ability in terms of any mental age; and a third reason is that the scores of the different tests should be weighted to take into account different degrees of efficiency of different tests.

After having found the curve of relation between age and degree of performance in each of the tests, then through the medium of the age scale the correspondence of degrees of performance in each test scale can be found with those of every other. It would then remain to transmute measures of the various degrees of performance in each test from age values into units of the absolute scale. Various methods could be suggested for accomplishing this. One would be to find the percentage of adults which pass that degree of performance in each test corresponding to ten-year ability, to find the absolute value corresponding to the median of these percentages and to consider this as being the absolute value which corresponded to ten-year ability, etc. A more refined method might be used which involved a comparison of the variabilities of the distributions of grades of intelligence of the children of the different ages for the purpose of determining the curve of growth of intelligence. Thus we might find the correspondence of the age scale determined as suggested above, to be that shown in Table III.

TABLE III

3	4	5	6	7	8	9	10	11	12	13	14	15	16	18
20	27	34	41	48	55	62	68	75	81	87	92	95	98	100

We have assumed that the distributions of absolute grades of intelligence attained by the children of each age were normal distributions having variabilities proportional to the values of their central tendencies (this will be the case if our hypothesis regarding the growth of general intelligence is true), and have considered it possible to so graduate our absolute scale that the quotient obtained by dividing the actual absolute grade of intelligence of any child by the absolute grade which is normal for

children of his age would give us an absolute intelligence quotient (A I Q) which is constant for a given child throughout all ages and may be taken as the "coefficient of brightness" of the child and as a measure of the degree of brightness which he will have also when an adult. By means of this "absolute intelligence quotient" obtained for any child we may predict the probable ultimate absolute grade of intelligence which he will reach and thereby predict the probable maximum intellectual attainments which he will achieve.

Weighting the Scores According to Value as Measures of Intelligence

If we merely found the average or median level of ability attained in a series of tests by a given child, we would be assuming that all tests were of equal significance as measures of intelligence. As has been stated, however, certain tests are much more significant than others. This may be due to finer scale gradations or to more time devoted to giving the test or to the fact that the ability tested is less dependent upon factors other than those which we consider as constituting intelligence. The tests should be weighted, therefore, according to their significance as measures of intelligence.

There are several ways, of course, in which this could be done. One would be to make use of a criterion of intelligence apart from the tests, to which they would be compared. Thus we might get as reliable an estimate as possible of the intelligences of pupils by their teachers and find the manner of combining the results of the tests which would give the best approximation to that estimate. The method generally employed in such a case is that of partial correlation and the regression equation.[9]

Another and perhaps better method of weighting the test results could be employed in which no external criterion was used. Thus McCall[10] finds the amount of correlation between each test and a measure obtained by combining the measures of all the tests when these were weighted by "guess." It may be shown, however, that a very good approximation of the relative degrees

---

[9] See G. Udny Yule, *An Introduction to the Theory of Statistics*, Chapter 12, or Truman L. Kelley, Bulletin of the University of Texas, 1916, No. 37.

[10] W. A. McCall, *Correlations of Some Psychological and Educational Measurements with Special Attention to the Measurement of Mental Ability*. School and Society, January 6, 1917.

in which each test measures a factor common to all the abilities tested may be found by a consideration of the amounts of intercorrelation between the tests taken singly. Proof of this may be derived from the formula for partial correlation.

Assuming that we have satisfactorily determined the weightings to be given each test result, an illustration will be given of the determination of the weighted average of the levels of attainment in the various tests, supposing that an abbreviated series of tests is being used consisting of the tests named in Table V. Let us assume that a child attained a degree of performance in each test which would yield the grade scores designated in column 2, and let us suppose the respective weights of the tests as determined in an approved manner are as shown in column 3. (These are made small numbers for convenience of illustration.)

TABLE V

1	2		3		4	5	6
Tests	Test Grade Scores		Weights		Weighted Scores	Altered Weights	"Points"
1. Digits.....	77	×	2	=	154	1.0	77
2. Similarities.....	83	×	3	=	249	1.5	125
3. Analogies.....	80	×	3	=	240	1.5	120
4. Completion.....	88	×	4	=	352	2.0	176
5. Discrimination...	65	×	1	=	65	0.5	32
6. Sentences.....	72	×	2	=	144	1.0	72
7. Vocabulary.....	95	×	5	=	475	2.5	238
Totals.....	7)560		20		20)1679		840
Average	80		Weighted average		84		

Now, of course, the sum of the weights may be made equal to any number so long as the proportions are kept the same. They may be altered, therefore, so that their sum equals 10 (using decimal fractions). Moreover, the values of the grade scores for each test may be multiplied by the proper weight thus found and a new table made for each test in which the weighted score in "points" can be read directly, opposite the degree of performance attained. Thus for the sentence test, the correspondence of the degrees of performance (number of sentences repeated) and the absolute grade of ability reached (measured on the absolute scale) and the number of "points" (weighted absolute grade) might be as shown in Table VI.

According to this scheme, the weighted average of the absolute scores of a person achieving median adult performance in

each test would be 1000 "points." That is, 1000 points equals a score of 100 on the absolute scale and, as may be shown, all other scores in points would be just 10 times the corresponding scores on the absolute scale. The latter might now be discarded having served its purpose as the basis for the construction of a "point scale" consisting of weighted scores corresponding to the degrees of performance in each test.

The Chart

In the Chart we have this Point Scale in the center with 1000 points as median adult intelligence. Values of the grade may be considered as $^1/_{10}$ of each number of points. On the left are curves postulating the growth of absolute intelligence. On the right are scales of degrees of performance in nine tests assumed to constitute an abridged series with their corresponding numbers of points.

TABLE VI

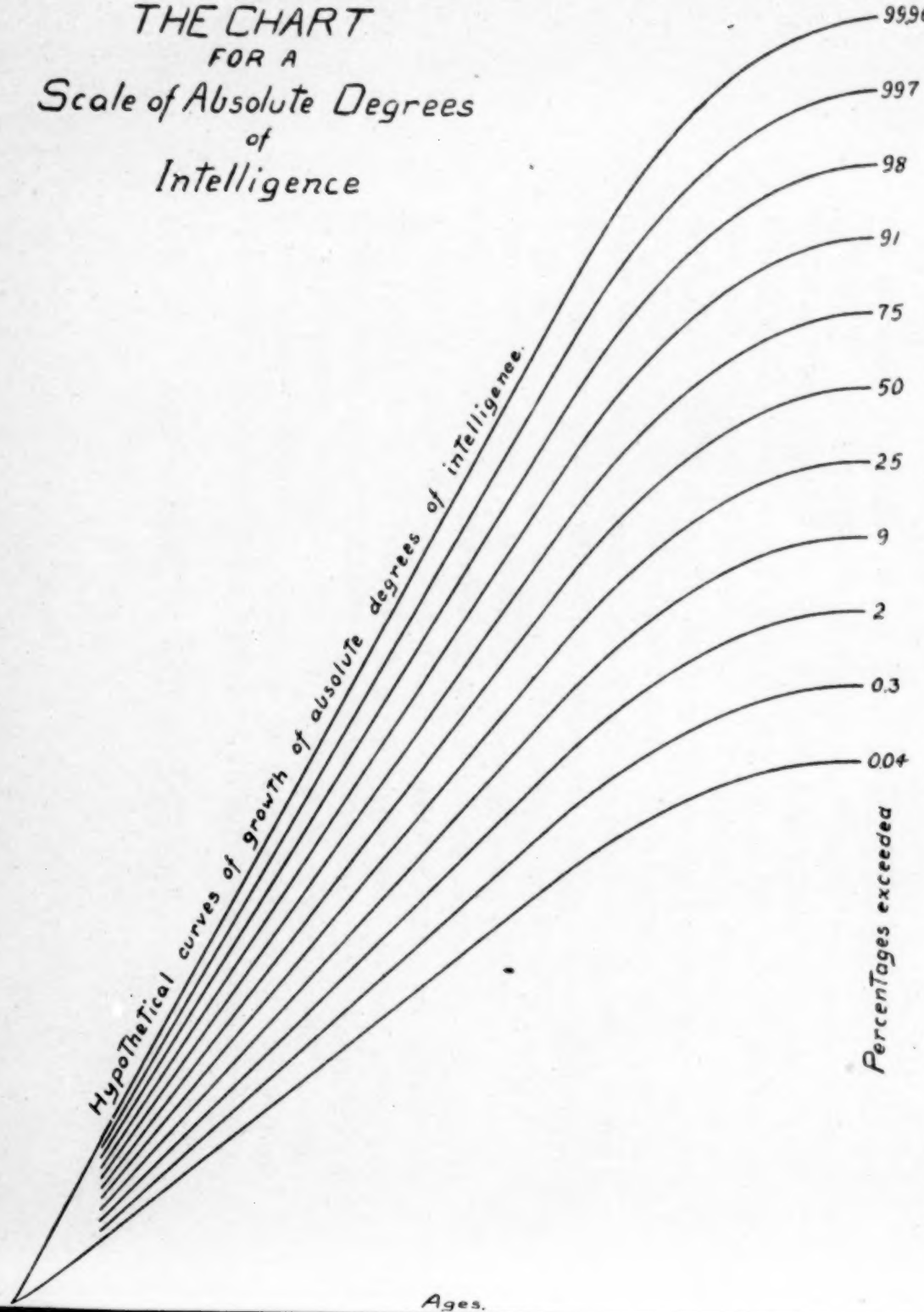
Hypothetical Corresponding Scales for a Sentence Test

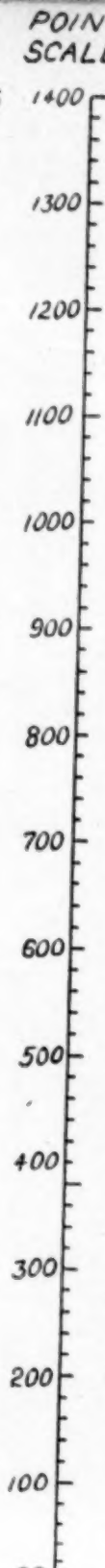
Number of sentences.....	1	2	3	4	5	6	7	8	9	10	etc.
Absolute grade of ability required.....	20	22	25	30	39	52	65	78	89	100	etc.
Points (Weight 2/6.7).....	6	7	8	10	13	18	22	26	30	33	etc.

Thus we see that to find the number of points designating the absolute degree of general intelligence of any individual, it is necessary merely to find the degree of performance which he can achieve in each test, note the number of points in the chart corresponding to this degree of performance, find the sum of those numbers of points for all the tests and this sum will be the "point-score" which denotes the absolute degree of intelligence of the individual in the determination of which due consideration has been given to the different degrees of efficiency (reliability and correlation with intelligence) of the various tests and which point scores are expressed in units which are equal according to the theory of normal distribution of grades of adult intelligence.

From this "point-score" which may be used to denote the absolute degree of general intelligence and the age of an individual, we may determine upon which curve of growth he is progressing, so to speak. Thus a 12-year-old with 880 points is progressing on the "75% curve" showing that he exceeds 75%

THE CHART
FOR A
Scale of Absolute Degrees of Intelligence





Hypothetical test scores and corresponding points.

Age Scale	No. Words Vocabulary (wt.5) Points		No. Words Completion (wt.5) Points		Number Opposites (wt.4) Points		Number Reasoning (wt.4) Points		Number Analogies (wt.3) Points		Number (wt.3) Points		Syllables Sentences (wt.3) Points		No. Counts Designs (wt.2) Points		No. Words Association (wt.1) Points	
18	65	167					16	134	16	100								
16	60	164	75	163							7	99	28	100	80	65	90	33
15	55	157			60	125	15	126	15	93	7¼	95						
14	50	152	70	148							7	91	26	92	75	60	70	30
13	45	143			55	113	14	119										
12	40	136	65	133			13	110	14	83	6	84	24	84				
11	35	125			50	105									70	53	55	27
			60	118	45	94	12	100			6½	77	22	75				
10	30	113							13	72								
			55	104	40	86	11	88			6	68	20	68	65	47	45	23
9	25	102							12	64								
			50	96	35	79	10	78			5½	60			60	40	37	20
8	20	90							11	58			18	57				
			45	88	30	72	9	70			5	54			55	35		
7	15	82							10	53							30	17
			40	80	25	66	8	63			4½	48	16	45	50	31		
6	10	67							9	47								
			35	70	20	59	7	56			4	40			40	27	23	13
5			30	62	15	53	6	52	8	43								
	8	50							7	39	3½	34	14	36	30	23		
4			25	54	10	44	5	44										
			20	46					6	35							20	10
					5	39	4	40			3	27	12	27	20	19		
									5	31								
							3	33										
									4	26								
3	5	33	10	33	2	29	2	28	3	23								
									2	21	3	20	6	20	10	14	18	7

99	233	100	233	80	186	20	186			12	140	50	142	99	93	250	47
98	225							20	135	11½	135	40	136				
95	217	95	217			19	170			11½	131	37	130	98	87	200	43
90	208			75	166			19	125	10½	127						
85	200	90	200							10	123	34	123	96	81		
80	192					18	156			9½	119					160	40
75	184	85	188	70	151			18	115	9	116	32	116	92	76		
70	174					17	144			8½	111						
		80	174	65	137			17	107	8	107	30	108	86	71	125	37
65	167					16	134			7½	103						
60	164	75	163					16	100	7	99	28	100	80	65	90	33
55	157			60	125	15	126			6½	95						
50	152	70	148					15	93	6½	91	26	92	75	60	70	30
45	143			55	113	14	119										
40	136	65	133			13	110	14	83	6	84	24	84				
35	125			50	105									70	53	55	27
		60	118	45	94	12	100			5½	77	22	75				
30	113							13	72								
		55	104	40	86	11	88			5	68	20	68	65	47	45	23
25	102							12	64								
		50	96	35	79	10	78			4½	60			60	40	37	20
20	90							11	58			18	57				
		45	88	30	72	9	70			4	54			55	35		
15	82							10	53							30	17
		40	80	25	66	8	63			3½	48	16	45	50	31		
10	67							9	47								
		35	70	20	59	7	56			3	40			40	27	23	13
		30	62	15	53	6	52	8	43								
8	50							7	39	2½	34	14	36	30	23		
		25	54	10	44	5	44										
		20	46					6	35							20	10
				5	39	4	40			2	27	12	27	20	19		
								5	31								
						3	33										
								4	26								
5	33	10	33	2	29	2	28	3	23								
								2	21	2	20	6	20	10	14	18	7

of persons in brightness, will attain an ultimate degree of intelligence represented by 1100 points and therefore has a "coefficient of brightness" of $^{1100}/_{1000}$ or 1.10 and may be expected to ultimately achieve the degrees of performance in the tests opposite the 1100 points on the Point Scale. In the finished chart, of course, a much larger number of curves should be drawn, or else these must be supplemented by a table composed of portions similiar to Table IB for every fractional year of age.

It is quite possible that in the actual making of a point scale as outlined above, some modifications in the arrangement of tests would be necessary, since certain tests which are excellent for persons above a certain age might be incapable of being used with very young children, such as those who could not read in the case of the completion test. In this case it would be necessary merely to substitute a suitable test in the lower part of the scale, the reliability of which was such that it would be weighted the same. In fact if the reliability of a single test were different for different extremes of the scale it could be divided, and each half could be completed with tests having the proper reliability. Scale arrangement on the Chart is of no consequence in giving the tests.

In postulating the absolute grades of intelligence which corresponded to certain degrees of performance in three of the tests, the vocabulary, digit and sentence tests in the Chart, reference was made to the Stanford Revision of the Binet Scale and the numbers of words of vocabulary, digits repeated on third trial, and syllables in the sentences repeated, were placed opposite the mental age corresponding to the age group in which these degrees were found. Thus since "Repeats 4 digits" was found in age group IV, 4 was placed opposite mental age 4 years.

The Making of a "Binet Point Scale"

Before taking up the specific criticism of the Yerkes-Bridges Point Scale, let us see how the Stanford Revision of the Binet Scale compares with our suggested point scale. For this purpose let us convert it into a point scale as far as possible. For the sake of conciseness let us denote the various tests by their numbers and catch names referring the reader to the test blank for a more complete knowledge of the tests.

TABLE VII

A Binet Point Scale

Point Scale	Mental Age	Points	List 1	Points	List 2	Points	List 3
12	III	2	(1) Body	2	(3) Pictures	2	(2) Objects
24	IV	2	(1) Lines	2	(2) Forms	2	(3) Pennies
36	V	2	(1) Weights	2	(4) Definition	2	(3) Comparison
48	VI	2	(1) Right and Left	2	(2) Pictures	2	(3) Pennies
60	VII	2	(1) Fingers	2	(2) Pictures	2	(4) Knot
72	VIII	2	(6) Vocabulary 20	2	(5) Definition	2	(4) Similarities
84	IX	2	(2) Weights	2	(1) Date	2	(5) Words
96	X	2	(1) Vocabulary 30	2	(3) Designs	2	(2) Absurdities
120	XII	4	(1) Vocabulary 40	4	(3) Fables	4	(8) Similarities
144	XIV	4	(1) Vocabulary 50	4	(2) Induction	4	(5) Arithmetic
168	XVI	4	(1) Vocabulary 65	4	(3) Fables	4	(6) Boxes
192	XVIII	4	(1) Vocabulary 75	4	(2) Paper	4	(5) Digits 7 back.

A Binet Point Scale—Continued

Point Scale	Mental Age	Points	List 4	Points	List 5	Points	List 6
12	III	2	(7) Digits 3	2	(5) Name	2	(6) Syllables 6–7
24	IV	2	(6) Digits 4	2	(5) Comprehen. 1	2	(7) Syllables 12–13
36	V	2	(6) Commissions	2	(5) Patience	2	(2) Colors
48	VI	2	(5) Coins	2	(4) Comprehen. 2	2	(6) Syllables 16–18
60	VII	2	(3) Digits 5	2	(5) Differences	2	(7) Days
72	VIII	2	(2) Counts	2	(3) Comprehen. 3	2	(1) Ball and Field
84	IX	2	(4) Digits 4 back.	2	(6) Rhymes	2	(7) Months
96	X	2	(7) Digits 6	2	(5) Comprehen. 4	2	(8) Syllables 20–22
120	XII	4	(6) Digits 5 back.	4	(2) Definition	4	(4) Ball and Field
144	XIV	4	(7) Digits 7	4	(3) Differences	4	(6) Clock
168	XVI	4	(5) Digits 6 back.	4	(2) Differences	4	(7) Syllables 28
192	XVIII	4	(3) Digits 8	4	(6) Ingenuity	4	(4) Memory

Suppose we consider the first test scale as made up of III, (1) Body; IV, (1) Lines; V, (1) Weights, etc., as shown in Table VII. We could in this way make up six "lists" of tests, each list corresponding to a "test" in the Chart and each test corresponding to a degree of performance in a test in the Chart.

Different degrees of the same ability are recognized in the Binet Scale in the following: Digits, Syllables, Definition, Comprehension, Pennies, Pictures, Vocabulary, Similarities, Weights, Time orientation, Designs (Forms), Ball and Field, Fables, and Differences. So far as possible, therefore, those of a kind have been placed in the same lists. Thus we see that List 4 is almost entirely made up of degrees of memory for digits.

In so far as any list is composed of tests representing different degrees of the same ability, such as vocabulary or memory for digits, it may be said that the ability to achieve a certain degree of performance, such as defining 30 words, or repeating six digits, presupposes possession of the ability to achieve all lesser degrees of performance in the same list and none of the greater degrees. This cannot be said, however, of any of the lists where the abilities are different, since a child might conceivably succeed in the tests III, IV, V, VIII and IX of List 2 and fail in VI, VII, as well as those above IX. It is perhaps fairly safe to say that his "average ability" in the tests of a single list is approximately represented by the age corresponding to his point-score in the list, even though the tests passed be not in consecutive order.

To use the Binet Point Scale, the tests constituting the regular Binet Scale would be given exactly as is usual. One should then note how many tests in each list were passed and find the sum of the points corresponding to each test passed, as indicated in the column headed Points. This sum would constitute the "point-score." The correspondence between the Point Scale and the Mental Age Scale at the left of the table has been arranged on the assumption that the passing of six tests (12 points) indicates mental age III, that the passing of twelve tests (24 points) indicates mental age IV, etc. A point score of 66 points (60 + 6) indicates a mental age of seven years (VII) and six months, a point score of 164 points (144 + 12 + 8) indicates a mental age of fifteen years and eight months, etc. Each point corresponds to an increment of one month in mental age. (Mental ages XVI and XVIII are fictitious.)

Specific Criticism of the Yerkes-Bridges Point Scale

It may be seen, therefore, that to convert the present Binet Scale into a point scale is merely to reorganize it on paper. As for the administering of the tests, as above mentioned, this would be done in exactly the same manner for our Binet Point Scale as for the Binet Scale. Even the scoring would be done in the same way. The only difference is in the manner of expressing the result—whether the degree of maturity of the child be spoken of in terms of "mental age" or "points." As a matter of fact the upper mental ages are merely arbitrary designations anyway, as has been said. In other words, we may say that *the present Binet Scale is already a point scale*, for all the purposes for which Yerkes' and Bridges' alteration[11] of the Binet Scale could be used. If Yerkes and Bridges had let each month of mental age by the present Binet Scale be called a "point" or given one "point" for passing each test, they would have had a series of "point scores" which would have "lent themselves readily to statistical work," as they say, including the use of different norms for different classes if desired, the comparison of mental ability with physiological maturity, etc. At the same time, the Binet scores thus converted would be more valid for the following reason.

Obviously, if a "point" has any meaning, it must stand for an increment of intelligence or intellectual maturity having the same value as that of every other "point," as nearly as possible. In the Binet Point Scale one "point" indicates one month's normal growth in intellectual maturity. In so far as months of normal growth are equal, the values of "points" in the Binet Point Scale are equal and therefore statistically valid. Those points coming near together in any part of the scale may be assumed to be practically equal (if the tests are properly standardized), as rate of growth probably changes gradually. In so far as the values of the points in the two ends of the scale are not equal (on account of slowing down in rate of growth) this error can only be corrected by some such method as we have outlined for making a point scale, in which "points" refer to equal absolute increments of intelligence.

---

[11] The "Point Scale" is practically the Binet Scale remodeled.

In Yerkes' and Bridges' alteration of the Binet Scale, however, even the time basis of equality in point values has been lost by a seemingly complete disregard for the necessity of having such values equal. One has but to examine Yerkes' and Bridges' alteration to note the absence of any apparent system in the assigning of points to increments of mental ability. For example, the abilities required to repeat series 3, 4, 5, 6, and 7 digits are assigned 1, 2, 3, 4, and 5 points, respectively. Now the assumption implicit in this arrangement, taken by itself, is that the increments of mental growth from each such ability to the next are all equal. Not only is no basis presented upon which this arrangement was made, but the indications of data strongly suggest that such is not the case, since the amounts of growth necessary to gain these four increments of ability, 3 to 4, 4 to 5, 5 to 6, and 6 to 7, digits are found to be approximately 1, 3, 3, and 4 years respectively, as indicated by the placement of these tests in the Binet Scale.

Similarly, one point is given in Yerkes' and Bridges' alteration for defining in terms of use each of the following words: chair, horse, fork, baby. Obviously, the difference between the ability to define one of these and the ability to define four of them in terms of use only, is not to be compared with the difference between ability to repeat four digits and the ability to repeat seven digits, though these differences are represented in both cases by increments of 3 points. We believe that these illustrations are sufficient to show that in altering the Binet Scale to make a point scale, Yerkes and Bridges have not only gained nothing over the present Binet Scale, since it is itself already a point scale for those who wish to say "points" instead of "months," but they have materially detracted from its value by a disarrangement which renders the value of a "point" quite meaningless. Such improvements as (1) the expressing of the degrees of intelligence in absolute units so that the value of one point is equal to the value of every other point and so that a given degree of brightness is expressed by the same coefficient at all ages, (2) the defining of the degrees of intelligence above that normal for adults in terms of the percentages of adults possessing these degrees, and (3) the weighting of the results according to the efficiency of the tests, are not even suggested in Yerkes' and Bridges' alteration of the Binet Scale.

Since the above was written, there has appeared in this JOURNAL an article[12] in which the defects of the Yerkes-Bridges arrangement of the Binet Scale are even more clearly shown than can be done by a consideration of the scale construction.

On page 604 of that article, the writers note the extraordinary fact that "During the fourth year of life, intellectual ability (always understood as measured by the point scale) increases more than fifty per cent.; during the fifth year of life, by scarcely more than thirty per cent.; during the seventh year, by approximately fifteen per cent." This shows the kind of results that may be gotten if one point is given to each of too many small increments of ability in the easy part of the scale, as suggested above in the case of defining words. It also shows what is deemed an altogether unwarranted confidence on the part of the writers in the power of numbers of arbitrarily assigned points to "indicate *directly* the rate, or annual increments of intellectual growth," (p. 603, italics mine) whereas the appearance of such questionable results should have immediately suggested to the writers the probability of an erroneous construction of the scale.

The obvious aim of intelligence measurement applied to children is to get a measure of the brightness of one child which is *comparable* with measures of brightness of other children of different ages. Presumably therefore, a measure of brightness which is valid, must stand for the *same degree of brightness* at all ages, which means that approximately the *same percentages* of children of the different ages should obtain any given measure of brightness.

Let us see how well this condition is fulfilled in the Yerkes-Bridges arrangement. In Table III in the above mentioned article a "coefficient" of 1.20 or more is attained by percentages of children of ages 4–5, 6–7, 8–9, 10–11, 12–13, 14–15, 16–17, 18-on, respectively, as follows: 34.5%, 33.0%, 15.8%, 13.7%, 5.5%, 6.5%, 0%, 0% (total number of individuals in the "normal group" upon which the measurements were taken = 1282). Certainly these "coefficients of intelligence" do not represent the *same degree of brightness* for the different ages. Obviously, therefore, they are not *comparable* with one another. Can they, therefore, be said to measure brightness or "intelligence" at all?

[12] ROBERT M. YERKES AND LOUISE WOOD. *Methods of Expressing Results of Measurement of Intelligence: Coefficient of Intelligence.* December, 1916, 593–606.

One can easily imagine a thoughtful investigator obtaining this amount of irregularity in what he hoped would be a valid measure of brightness, but it is inconceivable that in the face of such evidence of failure, one should be led into making the statement (p. 598) that "extraordinary intellectual ability is fairly common up to eight years, and then becomes very uncommon."

PRACTICE AND TRANSFERENCE IN NORMAL AND FEEBLE-MINDED CHILDREN

HERBERT WOODROW

University of Minnesota

PART II. TRANSFERENCE

The results obtained on the thirteen days' practice in sorting geometrical forms, by both the normal and feeble-minded practice groups, have already been given.[1] These results, it will be remembered, showed that the feeble-minded group, of average chronological age fourteen and average mental age nine, improved the same with practice as the normal group of average mental age nine. It remains to present the data on the transference of this practice effect, as seen in the end tests.

The end tests, given to all four groups, namely, normal practice and control groups and feeble-minded practice and control groups, were four in number. All four of the end tests were given on the same day, but given twice, so that two days were devoted to them at the beginning and at the end of the work with each group. They consisted of the following: sorting five lengths of sticks into five boxes of corresponding length; sorting colored pegs; a letter cancellation test; and a geometrical form cancellation test.

In the case of all the tests, the instructions were for speed only. As instructions for both speed and accuracy are inevitably ambiguous, nothing was said about accuracy. The children were told to see *how many* they could sort or cancel. The instructions were repeated practically in full each time the tests were given, and the children urged each time to do their very best. With these instructions, the proper method of scoring is the total number of elements correctly sorted or cancelled, and it is this number which has been taken in all the tests as the score. At the same time, the number of errors was recorded. Since, however, the errors were so infrequent (except perhaps in the stick sorting test), and, in view of the instructions, so unimportant, only the average error made by each group, each day, in each test, will be found given in the tables below. Space will not be taken to show the errors made by each child individually.

---

[1] Part I, this JOURNAL, Vol. 8, February, 1916, p. 85.

The end tests may be described more in detail as follows:

Stick sorting test.—This test consisted in sorting sticks of five different lengths, namely, 1″, 2″, 3″, 4″ and 5″. There were 40 of each length. These were shaken up in a large box, 6″ x 6″ x 1½″, and then sorted into small boxes. The small boxes had lengths just greater than those of the sticks. Each stick had to be sorted into the shortest box into which it would go. The sorting had to be done with one hand, one stick at a time. As the test seemed a rather hard one to understand, 2 mins. practice was given each time before the counted test. During this practice, any child picking up more than one stick at a time or putting any of the sticks into too long a box, was corrected. The time allowed for the counted test was 4 mins.

Peg sorting test.—This test was similar to the above, except that beaded pegs of five different colors (Bradley's Kindergarten Material) were used in place of sticks. Pegs of the same color had to be put into the same small box, but any color might be placed in any box. The number of pegs used was 150, 30 of each color. The time allowed was 3 mins.

Letter cancellation test.—Consisted in cancelling every *K* and *F* in a cancellation blank differing only in minor details from those ordinarily in use. The blank had 20 lines of letters with 56 letters in each row. The sheets were turned face down on each desk before the test began, and instructions given on how to hold the pencil and how to turn over the sheet at the signal to start. To show the children how to cancel, a line of letters was written on the black-board and the *K*'s and *F*'s cancelled. The letters were erased from the board before starting the test. Instructions were given to pass from left to right along each line, without skipping a line, the same as would be done in reading. The time allowed was 3 mins.

Geometrical form cancellation test.—Consisted in cancelling all the crosses and squares in a specially prepared blank on which were printed the same five forms as used in the form sorting practice test. The blank was the same size as the Woodworth-Wells substitution test blank, after which it was patterned, but contained four times as many figures, *i. e.*, 400 instead of 100. Instructions were given much as in the letter cancellation test. The time allowed was 2 mins.

TABLE IV

Initial Results on the End Tests with the Control Groups

	1st Day				2d Day				Average			
Group Normal	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms
1	88	113	50	56	111	102	75	78	100	108	63	67
2	73	100	80	71	111	96	101	77	92	98	91	74
3	67	100	79	78	92	95	99	84	80	98	89	81
4	123	136	87	61	131	132	120	89	127	134	104	75
5	65	79	68	71	80	74	92	83	73	77	80	77
6	83	89	82	67	89	87	92	80	86	88	87	74
7	98	93	74	64	109	118	96	70	104	106	85	67
8	85	94	65	82	99	85	83	95	92	90	74	89
9	66	99	62	50	77	97	95	74	72	98	79	62
10	81	84	70	60	78	86	87	67	80	85	79	64
11	97	126	86	68	123	129	119	94	110	128	103	81
Av.	84	101	73	67	100	100	96	82	92	101	85	74
M. V.	*13*	*13*	*9*	*8*	*16*	*15*	*10*	*6*	*13*	*15*	*9*	*6*
Av. Er.	5.0	0.4	0.4	0.2	5.0	0.0	0.0	0.0	5.0	0.2	0.2	0.1
F. M.	92	96	68	48	84	107	100	87	88	102	84	68
2	99	107	81	72	99	126	110	88	99	117	96	80
3	91	68	76	81	105	116	117	89	98	92	97	85
4	70	119	93	66	96	120	100	79	83	120	97	73
5	79	120	65	49	99	107	81	85	89	114	73	67
6	133	105	88	89	131	104	109	92	132	105	99	91
7	92	117	88	87	88	96	123	95	90	107	106	91
8	125	118	55	52	131	125	70	80	128	122	63	66
9	76	66	64	57	85	80	71	73	81	73	68	65
10	51	87	83	73	62	108	95	81	57	98	89	77
11	82	120	102	65	70	167	109	89	76	144	106	77
12	53	58	61	54	81	87	71	63	67	73	66	59
13	65	83	35	43	80	65	82	84	73	74	59	64
14	106	120	59	57	104	109	73	75	105	115	66	66
15	77	110	91	74	95	94	112	97	86	102	102	86
16	113	119	79	60	87	113	103	84	100	116	91	72
17	86	121	70	52	97	95	81	61	92	108	76	57
Av.	88	102	74	64	94	107	95	83	91	105	85	73
M. V.	*18*	*19*	*13*	*12*	*13*	*15*	*16*	*8*	*14*	*14*	*14*	*8*
Av. Er.	8.6	0.1	0.1	0.1	12.4	0.1	0.0	0.1	10.5	0.1	0.1	0.1

In order to interpret the results on transference obtained with the practice groups, it is first necessary to know the results obtained with the control groups, merely from the repetition of the end tests without practice in a related test.

With both the control and practice groups, the end tests were given at the same hour on the same days of the week and with the same number of days between the initial and final testing. With the normal control group, the testing was done one month later than with the normal practice group, the former being tested in December and the latter in November. In the case of the feeble-minded children, the end tests were given to both the practice and control groups at the same time, in two sections, one following the other by one week.

The results with the control groups are given in Tables IV to VII. The headings "Sticks" and "Pegs" refer to the stick sorting and peg sorting tests, while the headings "Letters" and "Forms" refer to the letter cancellation and the form cancellation tests. In Tables IV and V, as well as in the corresponding tables with the practice groups (Tables VIII and IX), the scores given under these headings are those obtained simply by counting the number of elements correctly sorted or cancelled. In the line headed at the left, "Av. Er.," is given the *average* number of elements wrongly sorted or cancelled.

Keeping in mind the equality of improvement shown by the normal and feeble-minded control groups, we may now turn to the results obtained on the end tests with the practice groups. These results are given in four tables, VIII to XI, which correspond with the four tables, IV to VII, on the control groups. As in the case of the control groups, the variability within the groups is great and yet the average initial ability of the two groups is very nearly equal in all the tests. Further, the initial average ability of the two practice groups very nearly coincides with that of the two control groups, as a comparison of Table VII with Table XI will show.

TABLE V

Final Results on the End Tests with the Control Groups

	1st Day				2d Day				Average			
Group	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms
Normal												
1	103	104	66	75	113	108	71	88	108	106	69	82
2	97	102	104	98	78	84	109	131	88	91	107	115
3	103	111	112	96	124	115	141	110	114	113	127	103
4	166	143	134	103	164	144	151	118	165	144	143	111
5	90	73	71	70	93	88	64	108	92	81	68	89
6	106	101	86	79	112	109	98	80	109	105	92	80
7	106	111	101	82	103	122	103	88	105	117	102	85
8	107	98	84	111	108	92	93	104	108	95	89	108
9	96	90	102	88	96	96	111	97	96	93	107	93
10	86	81	87	56	85	111	94	64	86	96	91	60
11	148	138	143	105	151	140	148	113	150	139	146	109
Av.	110	105	99	88	113	110	108	100	111	107	104	94
M. V.	*18*	*15*	*17*	*14*	*20*	*15*	*22*	*15*	*17*	*15*	*20*	*14*
Av. Er.	4.1	0.0	0.3	0.3	5.4	0.0	0.5	0.2	4.8	0.0	0.4	0.3
F. M.	101	106	92	86	121	104	101	105	111	105	97	96
2	112	97	110	97	119	111	125	106	116	104	118	102
3	127	110	104	83	131	99	129	105	129	105	117	94
4	78	104	92	82	88	128	110	96	83	116	101	89
5	106	93	92	64	96	102	84	83	101	98	88	74
6	130	122	101	105	135	113	114	101	133	118	108	103
7	110	122	125	101	128	109	166	128	119	116	146	115
8	129	140	110	80	130	137	121	97	130	139	116	89
9	97	96	83	79	100	79	96	103	99	88	90	91
10	72	128	110	93	86	124	123	94	79	126	117	94
11	75	155	132	123	138	143	134	142	107	149	133	133
12	73	87	87	70	76	98	81	74	75	93	84	72
13	82	86	68	67	81	74	74	76	82	80	71	72
14	123	102	81	97	132	117	104	95	128	110	93	96
15	102	96	122	102	93	99	135	108	98	98	129	106
16	109	111	107	79	125	123	111	73	117	117	109	76
17	112	132	86	65	103	125	101	86	108	129	94	76
Av.	102	111	100	87	111	110	112	98	106	111	106	93
M. V.	*16*	*16*	*14*	*14*	*18*	*14*	*17*	*14*	*15*	*14*	*16*	*12*
Av. Er.	9.2	0.0	0.3	0.1	7.8	0.4	0.5	0.3	8.5	0.2	0.4	0.2

It will be seen from Tables IV and V that the groups were quite heterogeneous,—that the variability within the groups was large. Yet, as Table IV shows, the average initial ability of the normal group very nearly coincides with that of the feeble-minded group. This equality in initial performance of the two groups, along with considerable variation among the individual members, is due to the manner of selecting the groups. The equality between the two groups persists, on the whole, through

the final trials. A comparison of Table V with Table IV will show that a considerable degree of improvement occurred between the first and the fourth, or last, trial. This improvement is very nearly the same, in each of the tests, for both groups. The results on the control groups, then, merely go to confirm those already reported on the practice test by the practice groups. In both cases, while there is marked individual variation, it is impossible to establish any significant difference in improvability between the normal and feeble-minded groups.

TABLE VI

Individual Percentages of Improvement in Final Results over Initial Results, Control Groups

	Normal				Feeble-Minded			
Child	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms
1	8	—1.9	9.5	22.4	26.1	2.9	15.5	41.2
2	—4.3	—7.1	17.6	55.4	17.2	—11.1	22.9	27.5
3	42.5	5.1	42.7	27.2	31.6	14.1	20.6	10.6
4	29.9	7.5	37.5	48.0	0.0	— 3.3	4.1	21.9
5	12.3	5.2	—15.0	15.6	13.5	—14.0	20.5	10.4
6	26.7	19.3	5.7	8.1	0.8	12.4	9.1	13.2
7	1.0	10.4	20.0	26.9	32.2	8.4	37.7	26.4
8	17.4	5.6	20.3	21.3	1.6	13.9	84.1	34.8
9	33.3	—5.1	35.4	50.0	22.2	20.5	32.4	40.0
10	8.0	12.9	15.2	—6.2	38.6	28.6	31.5	22.1
11	36.4	8.6	41.7	34.6	40.8	3.5	25.5	72.7
12					11.9	27.4	27.3	22.0
13					12.3	8.1	20.3	12.5
14					21.9	— 4.3	40.9	45.5
15					14.0	— 3.9	26.5	23.3
16					17.0	0.9	19.8	5.6
17					17.4	19.4	23.7	33.3
Av.	19.2	5.5	21.0	27.6	18.8	7.3	27.2	27.2
P. E. Av.	*3.0*	*1.5*	*3.4*	*3.6*	*2.0*	*2.2*	*2.8*	*2.7*

In Table VI, is given the percentage of improvement in each test for each child, that is, the difference between his average in the initial two trials and the final two, taken as a percentage of the initial average. It should be noted that the average percentage improvement given at the bottom line of the table is the average of the percentages of improvement shown by the children individually, not the percentage of improvement in the group averages. It is true that there is but little difference between the improvement in the group averages and the averages of

the improvements shown by the children individually. It is the latter, however, which is of most importance, and which, alone, enables one to ascertain the degree of reliability or unreliability of any general conclusions concerning the children as groups. The individual percentages of each group show great variation, but the averages of these individual percentages are strikingly similar for the two groups.

TABLE VII

Summary of Data on Control Groups

	Sticks		Pegs		Letters		Forms	
	Normal	F. M.	Normal	F. M.	Normal	F. M.	Normal	F. M.
Initial trials 1st day	84	88	101	102	73	74	67	64
Initial trials 2d day	100	94	100	107	96	95	82	83
Initial trials Av.	92	91	101	105	85	85	74	73
Final trials 1st day	100	102	105	111	99	100	88	87
Final trials 2d day	113	111	110	110	108	112	100	98
Final trials Av.	111	106	107	111	104	106	94	93
Av. % Gain	19.2	18.8	5.5	7.3	21.0	27.2	27.6	27.2
P. E. Av.	*3.0*	*2.0*	*1.5*	*2.2*	*3.4*	*2.8*	*3.6*	*2.7*
Diff. in % Gain	+1.4		−1.8		−6.2		+0.4	
P. E. of the Diff.	*3.6*		*2.7*		*3.4*		*4.5*	

The summary given in Table VII shows that in only one case, that of the letter cancellation test, is the difference between the two groups in the average percentage of improvement greater than the P. E. of the difference. Even in the letter cancellation test, the percentage of improvement for the feeble-minded is only 1.9 times the P. E. of the difference greater than for the normal group. In order that a difference between two averages may be safely accepted as significant, the difference must exceed four times the probable error of the difference. It may be said, then, that the results on the control groups have utterly failed to show any difference between the normal and the feeble-minded in the degree of improvement due to the repetition of the tests. There are great individual differences in improvability within each group, but no difference of any significance between the two groups.

TABLE VIII

Initial Results on the End Tests with the Practice Groups

Group	1st Day				2d Day				Average			
Normal	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms
1	140	92	70	55	129	136	119	95	135	114	95	75
2	72	110	73	56	99	126	104	65	86	118	89	61
3	47	104	64	66	113	141	76	69	80	123	70	68
4	88	101	77	72	107	112	120	89	98	107	99	81
5	104	90	63	63	94	114	68	74	99	102	66	69
6	105	68	63	94	125	112	81	113	115	90	72	104
7	87	98	49	49	100	116	70	53	94	107	60	51
8	77	91	77	72	109	121	93	88	93	106	85	80
9	71	77	54	42	77	78	63	46	74	78	59	44
10	87	100	87	65	134	110	111	90	111	105	99	78
11	84	73	54	52	97	80	68	85	91	77	61	69
12	63	89	71	67	78	85	83	80	71	87	77	74
13	73	102	86	64	67	104	96	85	70	103	91	75
14	78	84	74	67	102	109	101	76	90	97	88	72
15	102	106	89	70	122	91	102	88	112	99	96	79
16	69	92	77	49	86	106	87	71	78	99	82	60
Av.	84	94	70	63	102	109	90	79	94	101	81	71
M. V.	*15*	*10*	*10*	*10*	*15*	*14*	*17*	*13*	*14*	*10*	*12*	*10*
Av. Er.	1.9	0.4	0.4	0.8	1.9	0.0	0.5	0.0	1.9	0.2	0.5	0.4
F. M.	108	101	76	98	92	87	117	92	100	94	97	95
2	87	88	78	79	91	77	98	92	89	83	88	86
3	95	126	63	63	107	120	72	79	101	123	68	71
4	88	125	75	46	93	107	94	77	91	116	85	62
5	89	119	120	115	109	117	117	113	99	118	119	114
6	45	115	87	65	60	101	121	104	53	108	104	85
7	114	113	87	78	100	93	104	87	107	103	96	83
8	66	113	51	52	91	90	81	92	79	102	66	70
9	99	119	57	62	102	105	93	63	101	112	75	63
10	29	78	37	35	93	114	72	72	61	96	55	54
11	90	86	29	56	109	108	97	77	100	97	63	67
12	102	106	80	77	114	107	96	84	108	107	88	81
13	92	102	68	50	93	90	95	60	93	96	82	55
14	104	120	76	77	128	123	124	93	116	122	100	85
15	77	61	67	52	82	66	87	69	80	64	77	61
16	91	116	51	55	100	80	69	56	96	98	60	56
17	111	117	54	44	87	124	66	53	99	121	60	49
18	119	108	90	85	133	112	123	100	126	110	107	93
19	67	76	41	59	101	82	85	74	84	80	63	67
20	65	81	53	61	106	88	112	85	86	85	83	73
Av.	87	104	67	66	100	100	96	81	93	102	82	74
M. V.	*17*	*16*	*17*	*15*	*11*	*14*	*15*	*13*	*13*	*13*	*14*	*14*
Av. Er.	4.2	0.0	0.1	0.8	3.1	0.9	0.5	0.4	3.7	0.5	0.3	0.6

TABLE IX

Final Results on the End Tests with the Practice Groups

Group Normal	1st Day				2d Day				Average			
	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms
1	171	138	145	77	162	160	153	101	167	149	149	89
2	88	144	126	86	114	154	132	108	101	149	129	97
3	104	148	89	87	119	149	103	94	112	149	96	91
4	122	129	137	83	133	138	148	112	128	134	143	103
5	121	135	103	100	125	148	119	113	123	142	111	107
6	124	123	115	104	156	122	135	144	140	123	125	124
7	129	103	83	68	139	130	93	97	134	117	88	83
8	115	130	100	82	128	145	109	91	123	138	105	87
9	93	94	75	70	97	107	93	72	95	101	84	71
10	120	146	137	111	146	157	157	124	133	152	147	118
11	112	94	94	93	140	120	103	123	126	107	99	108
12	102	101	114	91	83	117	135	110	93	109	125	101
13	91	91	107	73	116	113	122	91	104	102	115	82
14	150	120	109	95	174	151	113	109	162	136	111	102
15	121	115	138	100	120	136	144	119	121	126	141	110
16	113	128	99	79	133	151	102	94	123	140	101	87
Av.	117	121	111	88	130	137	123	106	124	130	117	98
M. V.	*15*	*20*	*17*	*10*	*18*	*15*	*18*	*13*	*15*	*15*	*18*	*11*
Av. Er.	2.7	0.0	0.5	0.4	3.6	0.0	0.3	0.0	3.2	0.0	0.4	0.2
F. M.	111	126	137	109	104	121	150	109	103	125	144	109
2	99	99	95	93	110	94	102	120	105	97	99	107
3	139	167	98	97	129	153	94	104	134	160	96	101
4	112	134	122	105	118	162	135	121	115	148	129	113
5	119	154	161	145	139	162	167	152	129	158	154	149
6	136	137	110	96	131	148	147	106	134	143	129	101
7	128	156	115	97	131	136	110	117	130	146	113	107
8	107	132	103	96	132	135	137	115	120	134	120	106
9	121	112	83	90	99	121	89	113	110	117	86	102
10	82	81	55	48	87	100	82	57	85	91	69	53
11	129	143	114	83	138	150	113	103	133	147	114	93
12	147	90	107	109	139	104	117	113	143	97	112	111
13	92	111	81	72	104	108	115	86	98	110	98	79
14	113	179	119	103	134	179	137	112	125	179	128	108
15	79	63	92	84	90	77	99	88	80	70	96	86
16	107	127	77	62	105	135	84	66	106	131	81	64
17	121	154	87	72	147	141	92	79	134	148	90	76
18	160	149	143	108	153	150	146	102	157	150	145	105
19	149	168	102	85	154	135	123	105	152	152	113	95
20	108	119	109	76	104	102	114	85	106	111	112	81
Av.	118	130	106	92	122	131	118	103	120	131	111	97
M. V.	*17*	*24*	*19*	*15*	*18*	*20*	*20*	*15*	*17*	*23*	*18*	*15*
Av. Er.	4.8	0.0	0.3	0.5	3.5	0.1	0.2	0.5	4.2	0.1	0.3	0.5

Table X gives the individual percentages of improvement shown by the practice groups in the end tests after practice. It will be noted that here again there is great individual variability. Compared with the enormous individual differences, the differences between the averages for the normal and feeble-minded groups is impressively small.

TABLE X

Individual Percentages of Improvement in Final Results over Initial Results, Practice Groups

	Normal				Feeble-Minded			
Child	Sticks	Pegs	Letters	Forms	Sticks	Pegs	Letters	Forms
1	23.7	30.7	56.7	18.7	3.0	33.0	48.4	14.7
2	17.4	26.3	44.9	59.0	17.9	16.9	12.5	24.4
3	39.6	21.1	37.0	33.8	32.8	30.1	41.2	42.3
4	30.5	25.2	44.4	27.2	26.3	27.6	51.8	82.3
5	24.2	39.2	68.2	55.0	30.1	33.9	29.4	30.7
6	21.7	36.7	73.6	19.2	153.0	32.4	24.0	18.8
7	42.4	9.3	46.6	62.7	21.5	41.7	17.7	28.9
8	32.2	30.2	23.3	8.8	51.8	31.4	81.8	51.4
9	28.4	29.5	42.3	61.5	8.9	4.5	14.7	61.9
10	19.8	44.8	48.4	51.3	39.3	—5.2	25.5	—1.8
11	38.3	39.0	62.2	56.5	33.0	51.5	81.0	38.8
12	31.0	25.3	61.6	36.5	32.4	—9.3	27.3	24.7
13	48.6	—1.0	26.4	9.3	5.4	14.6	19.5	43.6
14	79.8	40.2	26.1	41.7	77.5	46.7	28.0	27.1
15	8.0	27.3	46.8	39.2	0.0	9.4	24.7	41.0
16	57.6	41.4	23.2	45.0	10.4	33.7	35.0	14.3
17					35.4	22.3	50.0	55.1
18					24.6	36.4	35.5	12.9
19					80.8	90.0	79.4	41.8
20					23.1	30.6	34.9	11.0
Av.	34.0	29.1	45.7	39.1	35.4	28.6	38.1	33.2
P. E. Av.	*2.8*	*2.0*	*2.6*	*3.0*	*5.0*	*3.2*	*3.1*	*2.9*

Now since the work with the control groups showed that improvement due to mere repetition of the tests was the same for both the feeble-minded and normal groups, the percentages of improvement shown by the practice groups may be compared directly, without correction for repetition, to determine which group shows the greater transference.

The average percentage of improvement for both the feeble-minded and normal groups, for each test, as well as the difference in these percentages is given in the lower part of Table XI. In the bottom line of this table is given the probable error of the

TABLE XI

Summary of Data on End Tests with Practice Groups

	Sticks		Pegs		Letters		Forms	
	Normal	F. M.	Normal	F. M.	Normal	F. M.	Normal	F. M.
Initial trials 1st day	84	87	194	104	70	67	63	66
Initial trials 2d day	102	100	109	100	90	96	79	81
Initial trials Av.	94	93	101	102	81	82	71	74
Final trials 1st day	117	118	121	130	111	106	88	92
Final trials 2d day	130	122	137	131	123	118	106	103
Final trials Av.	124	120	130	131	117	111	98	97
Av. % Gain	34.0	35.4	29.1	28.6	45.7	38.1	39.1	33.2
P. E. Av.	*2.8*	*5.0*	*2.0*	*3.2*	*2.6*	*3.1*	*3.0*	*2.9*
Diff. in % Gain	—1.4		+0.5		+7.6		+5.9	
P. E. of the Diff.	*5.7*		*3.8*		*4.0*		*4.2*	

difference, so that we may express the difference found in terms of the probable error of these differences. Calling a difference which shows greater improvement for the normal children plus, and one which shows less improvement for the normal children minus, the differences obtained in the percentages of improvement are as follows: Stick sorting test, —0.24 P. E.; peg sorting test, +0.13 P. E.; letter cancellation test +1.9 P. E.; form cancellation test, +1.4 P. E. Remembering the rule that a difference must exceed four times the probable error to be significant, it is evident that in no case is there a difference between the groups which begins to be significant. The differences do not differ in any other way than one might expect, in view of the variability within each group, were there no true differences between the groups.

It should, of course, be noted that the conclusion to be drawn is a negative one. It is that no reliable difference in the degree of improvement or of transference shown by the two groups can be found in the present data. This does not mean, on the other hand, that a reliable equality of the groups has been demonstrated. A demonstration of the latter sort is practically impossible in psychological matters. All we can do is to accumulate more and more data and then if the conclusions continue to be

negative, assume with more and more certainty that, if any true differences exist, they are of negligible importance.

It should be noted, further, that the unreliability of these differences is determined in a way which is not affected by the absolute size of the averages between which these differences exist. The unreliability of these differences is not affected, therefore, when we decrease the averages of improvement of the practice groups by subtracting those of the control groups. The remainders give the percentages of improvement which may be regarded as due to transference apart from improvement due to mere repetition of the end tests. Since the results on the control groups show substantial equality in the improvement of these groups, and indicate that the found differences between them are due to accidental variation, one may simply subtract the average percentages of improvement of both control groups from those of the practice groups in order to find out how much the improvement of the latter was due to transference. By so doing, we obtain the following average percentages of "pure" transference: stick sorting test, 15.7%; peg sorting test, 22.5%; letter cancellation test, 17.7%; form cancellation test, 8.8%. These percentages are small. There is no evident reason, however, why they are not large enough to permit the demonstration of a difference between the normal and feeble-minded groups, providing this difference were great enough not to be swamped by the individual variability.

We may now consider the general outcome of the present investigation. The feeble-minded children, averaging fourteen chronologically, may be regarded as practically arrested in mental development. Their average mental age five years hence will pretty certainly not increase by more than one year. The normal children, on the other hand, will pretty certainly go on increasing in mental age as fast as in chronological age for some years to come. Yet, so far as the present data go, the feeble-minded children respond to practice as readily as the normal children. General experience has long since demonstrated that feeble-minded children can do pretty much everything that a normal child of the same mental age can do. Indeed, they do some things much better than a normal child of the same age ever does, simply because they remain at a given mental age long enough to obtain the maximal skill compatible with that

mental age. The preceding results go beyond general experience merely in suggesting that the feeble-minded child not only can learn to do the same things that a normal child of the same mental age can do, but that, on the average, he can learn them equally rapidly. This seems plausible enough. If children have the same mental age, does this not mean that they should manifest the same ability, and if so, that they should show not only the same initial ability but the same ability after practice? Now, if this suggested conclusion be true, it means that when a feeble-minded child requires several years to gain one year in mental age, this is not because he is learning more slowly than the normal child. If it is not inferior ability to learn which keeps the feeble-minded child from becoming normal, what is it?

To this question, several answers occur. It may be that the feeble-minded child, though he improves with practice the same as the normal, does not retain his improvement as well. No data bearing on this possibility have here been obtained; but against it, is the fact, that the degree in which the memory of feeble-minded children falls below that of normal children is not commensurate with the degree in which feeble-minded children fall below normal children in general intelligence.[2]

Again, it might be that the feeble-minded improves with practice in the thing practised as much as the normal child, but that he is less able to benefit from this practice when he turns to somewhat different activities, in short, that he shows a lesser degree of transference. The preceding study throws grave doubt on this supposition. The data obtained, while not proving that the feeble-minded show exactly the same amount of transference as the normal, indicate that the difference, if any really exists, is slight,—far too slight, it would seem, to explain the difference between the rates at which normal and feeble-minded children increase their mental age.

The answer to the question, then, what determines the rate at which a child changes from one mental age to another, so far as the present study suggests one, is negative. It is that this rate of change is *not* due to capacity to improve with practice or to obtain transference effects. It follows, with considerable plausibility, that the determining factor is solely the capacity to grow.

---

[2] G. E. JOHNSON. Journ. of Psycho-Asthenics, Vol. II, 1, 1897, pp. 68–69.

In the mind of the writer, then, the present results show, in a striking manner, the distinction between ability to learn and the ability to grow. We are apt to think of these as inseparable. In the normal child, they usually appear so. But the present data indicate that the capacity to improve with practice is no index of the capacity for mental development, that is, of the capacity to change from one mental age to a superior one. This finding is the reverse of the one expected at the beginning of the investigation. Feeble-minded children, having very little capacity for mental development, were yet found to show no reliable difference from normal children in the capacity to improve with practice. It follows, then, as far as the present data go, that *in children of the same mental age, there is little or no correlation between ability to improve with practice and ability to change from one mental age to a higher one, between ability to learn and the ability to grow.* This conclusion, of course, has no bearing on the question as to the value of a practice test as a test of mental age.

In conclusion, it should be emphasized that the present results were obtained from practice continued for only a short time. Now, in practice which is continued sufficiently long, there will be improvement which is not really due to practice, but to growth; and in such practice, no one can doubt that normal children would, in many cases, outstrip feeble-minded of the same mental age. This would occur in all cases of mental work except those, if there are such, in which the maximal performance, with the limit of practice, is as good at the mental age used as at a superior age.

To determine whether there are any such kinds of work, and if so, what they are for each mental age, is one of the most important problems in the psychology of mental development, as well as a very practical problem in the psychology of the feeble-minded. We have a number of "curves of mental growth," but to what extent the rise in these curves is due to increase in mental age and to what extent to practice in identical or allied functions can only be determined by plotting the curves of maximal ability, at the limit of practice, for the different mental ages. For example, the difference between an adult and a nine-year-old child in a simple sorting test is very great at the first trial; but it is very much less at the limit of practice, since the child improves in this test much more than the adult. To what extent

is the same thing true of memory tests, of speed in writing, of lace-making, etc? Certainly growth curves of ability at the limit of practice would look very different from, and make an interesting comparison with, those of initial ability.

Summary

Feeble-minded children, of average mental age, nine, and chronological age, fourteen, were compared with normal children of the same mental age, with regard to practice and the transference of training. As regards practice, it was found that the normal and feeble-minded practice groups showed the same improvement in the test practiced, a form sorting test. Further, the normal and feeble-minded control groups showed the same improvement with repetition of the end tests, four in number. The conclusion is definitely indicated, therefore, that feeble-minded children improve with practice the same as normal children of like mental age.

As regards transference, the results were less definite. In two of the end tests, stick sorting and peg sorting, the average percentage of transference was practically the same for both groups. In the other two end tests, letter cancellation and form cancellation, the normal children showed a slightly, but not reliably, greater average percentage of transference than the feeble-minded. In general, then, no significant difference in the amount of transference was found between the normal and feeble-minded groups.

Since, as regards mental age, the feeble-minded children used are changing but little, while the normal children are changing rapidly, it follows, that the ability to change from one mental age to another is due to something else than the ability to improve with practice or the ability to secure a transference of the effects of practice. Since this something else is presumably the capacity for mental growth, the present data indicate an absence of correlation between the capacity to learn and the capacity to grow mentally. The degree of intelligence (mental age) is a condition of the rate of learning; but the rate of learning does not affect the rate of growth in intelligence.

CONFUSION IN RECALL

GARRY C. MYERS

Brooklyn Training School for Teachers.

The tendency to confusion in learning has long been a subject of study in psychology, under the titles *inhibition* and *interference*. But the more treacherous tendency to confuse associates, which seem, at least, to have been formed correctly, with the wrong members of a pair of other associates, *i. e.*, confusion in recall, has hardly been considered. With a view to showing the extent of this tendency to confuse in delayed recall what was not confused in immediate recall; or, to show how much confusion tends to increase with time, between the first mastery and recall after considerable time, a few tests and observations have been made.

While teaching history to a group of 36 rural teachers the writer received among other answers, the following: "Monroe Doctrine was the doctrine in which Monroe could remove any one from office who did not have the same view as he did." "Monroe Doctrine—That Kansas and the other states should come in as free and slave states." "The Monroe Doctrine said that a certain number of states should be made out of the Northwest Territory. The boundary line was fixed at 36° 40′. Slavery should exist north of this boundary line." "Monroe Doctrine—Any foreigner deemed injurious to U. S. should be considered an unfriendly act." "Monroe Doctrine—Was the people said that if any body should say anything horse about the President would be considered an unfriendly act or to gain dominion over America should be fined or imprisoned." "British New York Campaign—Braddock was to come down to New York from the North, Rosecrans was to come from the West, and Burgoyne was to come from the South." "William Lloyd Garrison—Sec'y of War under President Wilson." "Secession means to go in order." "Carpet Baggers were people from the North that went South to travel."

The above are striking examples of confusion in recall. No doubt each student once knew the correct answers to the questions asked but meanwhile had gotten all or parts of the answer

confused with that of one or more other questions. It is significant that these teachers had practically all studied from Barnes' History of United States and had been accustomed to employ the rote memory method of studying history.

The materials most readily confused, theoretically, are those least meaningful. Formal Logic, therefore, ought to be rich in offering cases of confusion in recall. From a large collection of confusions gathered during a half year's course in formal logic a few examples, collected at different times are given here: In one written lesson six out of 23 confused the various *figures* one with another; five confused *collective* and *general* terms; and three *concrete* and *abstract.* When asked to convert a given proposition and then to obvert another given proposition 16 out of another group of 28 correctly *obverted* the one they labeled *converted.* Not one made a mistake in the operation *per se.* They had confused entire units. These answers were all given to questions which were asked unexpectedly, several weeks after the material called for had been studied in class.

A more definite test of this problem was made on a group of 50 students six months after they had finished the subject of logic. They were asked five simple questions which the teachers of logic in that school considered the A B C's of the subject. Since these students had been promoted it is fair to assume that the confusions indicated are confusions of delayed recall. Three showed such confusion among *abstract, collective,* and *general* terms; eighteen indicated some form of confusion in transposition (conversion, obversion and contraversion). Eleven confused formal *deductive fallacies* with *inductive fallacies.* When asked to indicate the position of the middle term in each of the four *figures* one confused first and fourth, one confused all four with one another, six confused with *moods,* and 13 had from one to four displacements of symbols within the *figures.*

The familiar character-word association tests, *a* and *b,* by Thorndike were given to 40 normal school girls. After *a* was recalled a diversion of five minutes was improvised before the *b* test was given. One and one-half minutes were given for learning and for recall. After one day the subjects were asked unexpectedly to recall again, and a third such recall was made after 3 weeks.

TABLE I

Character-Word Association Test

40 Subjects

Recall		Percentage of Correct Recalls Properly Associated		
		Test A		Test B
First		89.4		100.
Second	and	87.1	charm	97.1
Third		78.9		84.0
First		88.2		100.
Second	are	79.1	John	87.9
Third		62.5		72.0
First		90.3		100.
Second	sect	95.2	grit	89.5
Third		66.6		100.
First		79.3		97.4
Second	hope	76.5	place	82.2
Third		60.0		90.9
First		88.6		94.7
Second	mess	100.	flag	96.3
Third		84.2		85.2
First		94.7		90.3
Second	rein	93.7	bar	82.3
Third		88.2		87.7
First		84.4		78.8
Second	pick	94.4	bung	78.3
Third		70.0		75.0
First		100.		85.7
Second	four	96.6	nymph	77.4
Third		86.2		56.3
First		100.		96.9
Second	nose	97.3	dent	100.
Third		90.		100.
First		92.6		96.8
Second	meet	84.2	yet	86.4
Third		66.6		84.6

Table I gives the percentage of correct recalls that were properly associated. This is given for each word in both tests for the three successive recalls. It is obvious that a decrease in this percentage indicates an increase of confusion. This means that in delayed recall, there was increased tendency to attach the several words to the wrong character. Therefore the figures show for each word in test *a* and for all but two in test *b*, a pronounced increase in confusion after 3 weeks (third recall). The increase, however, for recall after one day is slight and for some words there is a positive decrease in confusion. Primacy and recency seem to play no part.

A second test purposely designed to confuse was employed. It was given also to study some factors in delayed recall and the value of working against time. Only those results dealing with confusion will be considered here. The records for working against time and for working at leisure are combined into one group. The test follows:*

273	732	372	723
beat	tow	desert	waist
statue	meat	week	pear
dessert	waste	stake	toe
steak	kernel	beet	meet
weak	pair	statute	colonel

The subjects were told that they would be given a slip of paper upon which were four columns of words with a three place number at the head of each column, that on the signal "go" they would study the material so that they could reproduce the words under their appropriate number, but that the words did not have to be learned in order.

In recording the data the order of a number if not in the correct column-position was counted correct if more than half the words which appeared beneath were properly associated with the number. Likewise if more than two of the words of a column were the same as the original they were counted correct, even if the proper number appeared elsewhere, or was absent, or even if no other number headed the column. In case one of these exceptions occurred the column order as a rule prevailed, *i. e.*, words often were reproduced in the original column regardless of the number heading it. Introspections from the maturer students concur in showing that the numbers as a rule were learned as to column then the words in like manner, and that despite the directions number-word association was not always made. Two subjects out of 50 said they did not see the number at the end of the column, on study, at all. Most said they studied columns 1 with 3 and 2 with 4. Because of the obvious difficulty in handling the data there was really more confusion than the tables reveal.

Two hundred and seventy-eight school children, from the sixth grade to the high school, of Honesdale, Pa., and 195 chil-

* A later test has proved more desirable: "The tailor bought the coat from the merchant. The farmer sold the pig to the baker. The baker sold the bread to the butcher."

dren from the schools of Bloomfield, N. J. were given the same test. The first schools were given 5 minutes to learn; the second 8 minutes (high school 7 minutes). Both schools were given 3 minutes for each recall and surprised by request for a second recall after 1 day. In all the tests with this experiment after the second recall a list of the numbers and words were presented in two columns distributed by chance and the subjects were asked to reconstruct them associating the words with their respective numbers. Honesdale schools were also tested unexpectedly after 3 weeks. The data for the third recall, and for reconstruction are not considered here. Both these schools were tested by Mrs. Myers; the other tests were made by the writer. Much credit is due Superintendents Oday and Morris for their hearty coöperation.

TABLE II

Average Per Cent. Correct Recalls in Correct Order

	Honesdale					Bloomfield				
		Words		Figures			Words		Figures	
Subjects		Immediate Recall	Recall After 1 Day	Immediate Recall	Recall After 1 Day	Subjects	Immediate Recall	Recall After 1 Day	Immediate Recall	Recall After 1 Day
High School										
F.*	87	72.4	66.2	74.4	69.2					
M.	72	70.0	54.6	74.3	71.8	M.	29	92.1	80.3	80.6	50.3
T.	159	71.3	60.9	74.4	70.4					
Eighth Grade										
F.	22	94.3	67.4	61.4	38.8	F.	68	90.1	79.9	68.9	54.3
M.	25	65.2	59.0	84.7	62.7	M.	48	78.0	68.5	52.5	35.7
T.	47	78.8	62.9	73.8	51.5	T.	116	85.1	66.6	62.1	46.6
Seventh Grade										
F.	24	49.4	34.9	62.4	35.2	F.	25	85.2	74.7	56.0	46.0
M.	11	70.6	49.1	43.2	15.4	M.	25	82.5	65.6	62.6	46.9
T.	35	56.1	39.7	53.3	27.4	T.	50	84.4	70.1	59.3	46.4
Sixth Grade										
F.	19	48.6	40.7	57.8	46.2					
M.	18	77.0	48.4	66.2	53.2					
T.	37	60.0	43.7	61.9	49.6					
Total										
F.	152	66.3	58.9	67.8	56.5	F.	93	88.8	78.5	59.6	52.1
M.	126	70.1	54.1	72.4	62.5	M.	102	83.1	71.1	63.0	42.6
T.	278	69.1	56.3	69.9	59.3	T.	195	85.8	64.4	61.3	46.6

*F=girls; M=boys; T=total.

The percentage of correct words and figures which were properly recalled is given in Table II. As in the other experiment, increased confusion is shown after a day but the increase is very pronounced and invariably obtains for figures and for words for the respective grades and for each sex, as well as for totals. There is no marked sex difference that is common to the several grades and to the two schools.

Considered from the viewpoint of the number of cases who had, in second recall, equal, greater, or less percentage of correct recalls than they had in the first recall, Table III shows that while a high proportion have the same, the number of cases whose second recall is inferior to the first is much greater than those whose second recall is superior. However, it is surprising that so many should improve the quality of their answers with time as indicated by the greater cases. In these cases time clarifies rather than confuses. For all the Honesdale schools, who had shorter time (5 min.) for learning, the number of "equal" cases for figures are fewer and the number of "less" cases are greater than for words. Therefore, with the number of "greater" cases about the same for words and figures, more tend to increase in confusion with figures than those who increase with words. However, the group percentages of Table II do not suggest this fact. Consequently, those who do confuse must confuse relatively to a less degree with figures than with words.

In spite of the increased confusion with time as revealed by the decrease in quality of delayed recall over immediate recall, the total correct responses regardless of position are, on the whole, greater in delayed recall than for immediate recall both for words and figures (Table IV). This is pronouncedly true for each sex of the high school and eighth grade but is not constant for the seventh and sixth grades. For the upper grades, therefore, the quantity of delayed recall is better than for immediate recall, while the quality is inferior. Probably the content, as one would naturally expect, was deemed relatively more important, and consequently clung better for delayed recall than for immediate recall. Indeed, the emphasis upon order in immediate recall doubtless inhibited considerably in recall of mere materials. It is significant that the predominance of content over order is more manifest in the higher grades and that the girls excel the boys in content, both for words and

TABLE III

Honesdale Schools

Number of Cases in Second Recall Who Had Equal (0), Greater (+), and Less (—) Percentage Than in First Recall

Subjects (F. and M.)		In Correct Order		Without Regard to Order	
		Words Cases	Figures Cases	Words Cases	Figures Cases
		High School			
159	0	55	36	32	75
	+	37	45	70	55
	—	67	78	57	29
		Eighth Grade			
47	0	16	6	7	20
	+	9	4	21	15
	—	22	37	19	12
		Seventh Grade			
35	0	16	6	2	16
	+	7	4	14	10
	—	12	25	19	9
		Sixth Grade			
37	0	17	2	4	16
	+	6	10	9	12
	—	14	25	24	9
		Total			
278	0	105	51	45	127
	+	60	64	113	92
	—	116	166	120	59
		Bloomfield Total			
195	0	45	36		
	+	48	62		
	—	102	97		

figures. No such sex-difference obtains for correct order unless the advantage is slightly with the boys (see Table II).

With the same experiment, 50 normal school girls who on the average took 7 min. 40 sec. to learn and 2 min. 20 sec. to recall, were tested individually. Their second recall was made in a group after 3 weeks. This was followed by the reconstructive test arranged by chance. Forty-one reconstructed more correct words and figures than they recalled. Four cases fewer, and 5 the same. For figures the respective data are 23, 8, and 19. On the average 5.16 more words were reconstructed in their proper places than the number thus recalled.

TABLE IV

Average Number of Words and Figures Correct Regardless of Order

Honesdale Schools

		Words		Figures	
		Immediate Recall	Recall After 1 Day	Immediate Recall	Recall After 1 Day
		High School			
F.	87	12.7	12.9	8.6	9.2
M.	72	10.3	10.7	8.5	9.5
T.	159	11.6	11.9	8.6	9.3
		Eighth Grade			
F.	22	11.7	11.7	9.5	9.7
M.	25	9.5	10.6	7.8	8.9
T.	47	10.5	11.1	8.6	9.3
		Seventh Grade			
F.	24	9.4	9.2	5.7	5.7
M.	11	9.5	8.7	6.2	6.9
T.	35	9.4	9.0	5.8	6.1
		Sixth Grade			
F.	19	9.9	9.4	8.1	7.8
M.	18	9.9	6.7	6.9	7.7
T.	37	9.9	8.1	7.5	7.8
		Total			
F.	152	11.7	11.7	8.2	8.6
M.	126	10.0	9.9	7.9	8.9
T.	278	10.7	10.9	8.1	8.7

While reconstruction gives far better records than recall, it is surprising that there should be any cases that did worse in reconstruction than in recall. Some showed, however, that the order they selected for the units was greatly influenced by the order as presented in the random group.

Their records for immediate recall were 97.2 per cent. and for recall after 3 months 65.7. For figures, they were 94.8 and 38.6 per cent., respectively.

Nineteen other girls of the same school were also tested for immediate recall, recall after one day and recall after 6 months. The records for words in the successive recalls were 95.7, 76.2 and 35.1 per cent., and for figures, 97.4, 66.2 and 13.2 per cent.

Twenty college men with the same test gave a percentage for immediate recall of 85.6 and for recall after 2 days of 65.7 for words and of 80.2 and 43.3 for figures.

In all the tests incorrect words and figures were exceptional and most of such that were given bear a close relation in form or meaning to the original words. This is in keeping with other findings of the writer.[1]

On the whole, therefore, while the total number of correct units recalled after one day is, as a rule, greater than for immediate recall, those units properly associated are decidedly fewer. On the average, confusions in immediate recall approximately ranged from 30 to 40 per cent.; in recall after a day, from 40 to 50 per cent.; recall after three weeks 65 per cent. and recall after 6 months, 85 per cent. Therefore, of the answers given there was a tremendous tendency at confusing the position of the several units which had been in correct or partially correct position, and confusion increased with time.

Pedagogical Significance

Just why A, for example, which when learned and recalled as properly associated with B, should later be recalled as associated with C, is not easily explained. Perhaps the explanation for most is in the erratic associates made during the study process. Even the weaker associates which gave place to the correct one in immediate recall, may be strengthened sufficiently as a result of later experience, to become the predominant associate at the time of delayed recall. Furthermore, unlearning experiences may have inhibited casual recall of the right associate, or its linking up with strengthening associates, or even the associations and emotional experience at the time of the delayed recall may favor the associate wrongly suggested in the first study. There is no certainty, of course, that all confusion was suggested in the first learning.

Whatever the cause, no doubt exists as to the prevalence of confusion in delayed recall. Every teacher is familiar with the patent type of answer which is in itself correct but which is not correct in response to the question asked. In the average written examination, doubtless the confusion errors preponderate over the errors of omission. It seems human to try to make some kind of a response to a situation and in consequence thereof,

---

[1] Myers, G. C. *A Study of Incidental Memory*, Arch. of Psychol. November 26, 1913. Pp. 64–65.
Myers, G. C. *A Comparative Study of Recognition and Recall.* Psychol. Rev., 21. November, 1914. Pp. 449.

one makes incorrect answers not so much because one cannot get an associate as it is because wrong associates obtrude themselves and seek expression.

In the learning process, then, wrong associates as far as possible should be prevented and every effort should be made to fix the right associate beyond doubt. Therefore the greatest care should be exercised to insure correct recitation because of its relation to the class as well as to the reciter. More important still, it is, that children perceive facts in their proper relations during study. Wherever possible the pupil should be led to make clear, definite classification of what he studies, so that there may be some strong points to which he can hitch the minor points of his lesson as he learns. He needs constantly to keep these "hitching posts" in view. Not only in the first learning, but in relearning and reorganization the learner should be guided so as to keep each element of his knowledge eternally associated with its proper mate. This study, furthermore, seems to emphasize the importance of drill.

COMMUNICATIONS AND DISCUSSIONS

THE PAINTED CUBE CONSTRUCTION TEST[1]

There is already a great host of mental tests, and we need experimentation with these instead of the invention of new ones. But occasionally a new test is devised which serves a special purpose not satisfied by any test previously described. Such a test is the Painted Cube Test, which has at least four special advantages, namely, it is a good "plus or minus" test of high-level intelligence, in this capacity it also calls forth many qualitative differences in mental reactions, it is in a measure a good means of testing for mental imagery, and it can be used as a means of measuring the upper levels of intelligence with blind and with deaf subjects.

This test was first described to me by Dr. J. M. McCallie,[2] who had used it to some extent in estimating the intelligence of eighth grade pupils. As employed by Dr. McCallie the test was given verbally, without apparatus. His instructions were: "Imagine a cube, three inches on each side, and painted all over on the outside. Now, suppose this cube were to be cut into inch cubes; how many of these inch cubes would be painted on three sides, how many would be painted on two sides, how many painted on one side, and how many painted on no side?" The subjects were also asked to explain their methods of obtaining the result, and to describe the accompanying imagery. He found that only a small minority of eighth grade school pupils were able to give the correct answer.

It seemed to me that this test might be used to better advantage as a test of intelligence if it were given with concrete material and with a correspondingly different procedure. This modification should make the test more adaptable to special types of language defectives, should tend to eliminate the aid of special imagery, and should provide a sort of manual-intellectual construction test which could be solved either by doing (trial and error) or by reasoning (analytic-synthetic thinking). The use of apparatus also makes the test practicable as a measure of high-level intelligence with blind and with deaf subjects, with whom the other procedure would not be satisfactory.

---

[1] Exhibited at the meeting of the Am. Psy. Assn., New York, Dec., 1916.

[2] Dr. McCallie has used this test since 1896, for his own purposes. It has also been used by G. H. Betts ("The Distribution and Functions of Mental Imagery," Teachers College Contributions, 1909), by F. E. Bolton ("Principles of Education," 1910), and by H. O. Rugg ("The Experimental Determination of Mental Discipline in School Studies," Educational Psychology Monographs, 1916).

Apparatus. The material for giving the test manually consists of 27 inch cubes of smooth, hard surface (Milton-Bradley kindergarten cubes, for example), eight of which are painted (with blind subjects, roughened) on three sides, twelve on two sides, six on one side, and one on no side.

Procedure. These cubes are strewn before the subject in a miscellaneous pile. The subject is told to "Take these cubes and build up a cube which shall be painted all over on the outside." The reaction time is recorded with an ordinary watch, but the examiner assures the subject that haste is not a major consideration. The examiner records especially the reaction procedures which the subject employs. He also requests the subject to describe and rationalize the mental processes which he employed, and the accompanying mental content. The reaction-method, whether viewed from the standpoint of introspection or of behavior affords unusual insight into the subject's type of thinking.

Results. We have not yet attempted to standardize this test with statistical accuracy. Judging from tabulated results from giving the test, with apparatus, to about twenty-five successful business men and advanced students in psychology, it appears that those who succeed complete the cube in from about three to twelve minutes. But it is astonishing how many of these subjects used the trial and error method, without analysis of the problem, and without caution in checking results. Many had no idea how many cubes should constitute one side of the completed cube; some subjects built as many as five on a side. Others who failed to employ analytic thinking did check the manual method as they proceeded with the test, but only a very few made such use of their minds as one likes to think Nature intended they should. As a test of intelligence level this test appears to measure superior average adult intelligence, as judged by these results and by others obtained from exceptionally bright children between 10 and 15 years of age, and with some adults of average and inferior average intelligence. For this purpose the speed of reaction is not so important as the type of reaction, when the speed is under about ten minutes. In other words, the test is a good qualitative measure as well as an age-level test. Success consists in finally obtaining a built-up cube painted completely on every side.

Blind and Deaf Subjects. This seems to be an excellent test with intelligent adolescent and adult subjects deprived of sight or hearing. Preliminary results indicate that with the blind it is a reliable measure

of superior intelligence, and with successful subjects is completed in from about eight to eighteen minutes. Miss Edith Taylor, to whom I am indebted for this information, writes that in addition there are striking differences in the mental contents of the congenitally and the "accidentally" blind subjects. The test has not yet been employed with deaf subjects, but from theoretical considerations should prove satisfactory.

This test appears relatively independent of special instruction and can be solved rationally without use of language or imagery. It is a problem, however, to discover the effect of these lacks in the test.

E. A. DOLL.

Vineland, N. J.

THE JOURNAL OF EDUCATIONAL PSYCHOLOGY

INCLUDING EXPERIMENTAL PEDAGOGY, CHILD PHYSIOLOGY AND HYGIENE, AND EDUCATIONAL STATISTICS

Published monthly except July and August by

WARWICK & YORK, INC.

LANCASTER, PA. BALTIMORE, MD.

Board of Editors

WILLIAM CHANDLER BAGLEY, CARL E. SEASHORE,
J. CARLETON BELL, Managing Editor, GUY MONTROSE WHIPPLE.

COLLABORATORS

Sydney Alrutz,	H. H. Goddard,	Will S. Monroe,	L. William Stern,
J. R. Angell,	Joseph Jastrow,	E. C. Moore	G. M. Stratton,
J. W. Baird,	G. E. Johnson,	M. V. O'Shea,	G. D. Strayer,
Bird T. Baldwin,	E. A. Kirkpatrick,	W. B. Pillsbury,	E. L. Thorndike,
W. Van Dyke Bingham	E. H. Lindley,	S. H. Rowe,	E. B. Titchener,
E. F. Buchner,	Anna J. McKeag,	Sante de Sanctis,	J. B. Watson,
W. H. Burnham	D. P. MacMillan,	E. G. Sanford,	W. H. Winch,
Ed. Claparede,	Adolf Meyer,	W. S. Small,	H. K. Wolfe,
S. S. Colvin,	J. B. Miner,	E. D. Starbuck,	A. H. Yoder.
W. F. Dearborn,			

Manuscripts for publication, books or other material for review, and news items of interest to educational psychologists should be addressed to The Managing Editor, J. Carleton Bell, 1032A Sterling Place, Brooklyn, N. Y.

The Journal is issuing a series of Monograph Supplements for the publication of more extensive researches in educational psychology. For details prospective contributors may apply to Warwick & York, Inc., Baltimore, Inc.

The price of the Journal is $3.00 per year of ten monthly issues. Foreign postage is 20 cents extra for Canada and 30 cents for other countries in the Postal Union.

Subscriptions and correspondence concerning business matters should be sent to Warwick & York, Inc.

VOLUME VIII MARCH, 1917 NUMBER 3

EDITORIAL

VOCATIONAL SELECTION

In the economic world, as in the field of biology, natural selection and the survival of the fittest have dominated the course of development. The struggle of competition is intense. Of the hundreds who enter any line of occupation only a few achieve success. Many of those who spend years in preparation or apprenticeship find themselves misfits, and are either entirely eliminated or drag out a routine existence as mere counters in the game. Thus in business, as elsewhere, we find natural selection very prodigal of life, very wasteful of time and energy. As society becomes more highly organized, more clearly conscious of its own strivings, it endeavors to facilitate the process of selection by artificial means, to utilize natural and human resources to their utmost, and to conserve time, energy, and human effort. Accordingly, we have the deliberate breeding of plants and animals for human needs, the eugenics movement in human biology, the great expenditures of money and thought upon modern universal education, and latterly the focussing of all the resources of applied psychology upon commerce and industry.

An interesting recent instance of the application of conservation methods to business is the establishment by the National Bank of Commerce in New York City of a Division of Employment and Education under the supervision of a trained psychologist. This bank, which is one of the largest in the country, has on its pay-roll between four and five hundred employees,—a number large enough to make many of our small colleges envious. The aim of the new division, according to the statement issued by the bank, is to "standardize scientifically the methods of selecting and training the employees of the institution. A careful analysis will be made of the sources of recruits, and of the influence of past training and life conditions upon the efficiency of each type of recruit, and upon the probable length of time that each one will remain actively in the work.

"A second line of procedure is the standardization of methods of selecting men for each special type of work, involving an analysis of the traits required for success in each line, as well as an analysis of each applicant to see whether he meets these requirements. Psychological tests will be adopted as aids in selecting employees and in estimating the value of each man to the firm. A special feature of this work will be the maintenance of a clinic along psychological lines to assist the employees in determining their special abilities and aptitudes. One of the important features of the selection of employees is the establishment of coöperative relations with universities, schools and other sources, so that the best material can be brought into the bank for training. Search will be made for young men of exceptional ability and training, who are interested in banking as a life work and who see in it a medium for developing the country's present and future resources.

"The second general feature of the work of the new division will be the more complete organization of a system of instruction designed to meet both the general needs of the employees, and the particular needs of each individual in the special line of work to which he has been assigned. This instruction will anticipate the needs of the men, and will place them in line for promotion. The basic idea in this is to make a course of instruction to fit the needs of the individual and of the institution, to the mutual advantage of both. A regular course of instruction embracing economics, commerce, banking and allied subjects, as well as the more elementary phases of bank work, will be established. The underlying purpose of the plan is to give practical training and at the same time develop the men along broad lines,

not merely as employees in a bank, but as individuals who can take their places in promoting and developing the resources of their country and of the commercial world. Thus the work is to be democratic, and is to be responsive to the desires of the employees as their needs arise from time to time. It is another concrete instance of the great movement in vocational education and vocational guidance that is now making itself felt."

It is worthy of special note that the foregoing program calls for an analysis of the factors that make for success in the various lines of banking work. If this can be carried out it will furnish a valuable contribution to the subject of vocational psychology. As Ayres has frequently pointed out, most of our efforts to use mental tests in vocational selection are nullified because we do not know what specific traits are characteristic of the successful man in the several vocational fields. The few sporadic attempts at the investigation of this question have yielded chiefly negative results. For example, engineers make little use of the mathematics that they are taught in school; classically trained students make as good a showing in the medical school as scientifically trained students; and shrewd men of affairs fail on some of the Binet tests of intelligence. We need much more intensive and prolonged studies of the essentials of vocational fitness. These should be conducted along two lines: first, an analysis of the characteristic traits of men who have succeeded in given lines of industry and a determination of the factors that were significant in their success; and second, a similar study of those who have failed and an inquiry into the reasons for their failure. When we have discovered, even in a vague way, the essential traits of a given industry, we can then more intelligently attack the problem of devising tests which will reveal the presence or absence of these traits in an individual, and of determining the prognostic value of such tests for the future success of the individual in the industry in question.

J. C. B.

NOTES AND NEWS

A Standard Score Card for Measuring Handwriting has recently been issued by Dr. C. Truman Gray of the University of Texas. The score card contains nine general rubrics, to each of which is assigned for a perfect score a certain number of points out of a total of one hundred. The assignment of these points was made on the basis of the author's recent monograph on the "Measurement of Handwriting," and is as follows: Heaviness, 3; Slant, 5; Size, 7; Alignment, 8; Spacing of Lines, 9; Spacing of Words, 11; Spacing of Letters, 18; Neatness, 13; and Formation of Letters, 26. The last rubric is divided into the following sections: General Form, 8; Smoothness, 6; Letters not Closed, 5; Parts Omitted, 5; Parts Added, 2. If each pupil's handwriting were scored at the beginning of the term on the basis of such a score card, the teacher would be greatly aided in focussing the pupil's attention upon the defects which should be remedied.

The experiment undertaken jointly by Teachers College and the New York City Board of Education at Speyer School something over a year ago is yielding interesting results. At the beginning of the school year 1915–1916 there were admitted to the school two hundred seventh grade boys who indicated, with the approval of their parents, their intention of taking the Latin course in the high school. These boys were divided into classes of twenty-five each, on the basis of extended mental and educational tests, supplemented by the subsequent judgments of their teachers. The aim was to secure as nearly homogeneous groups as possible and to adjust the work of the class to the capacities of the pupils. The teachers were carefully selected for their ability and their sympathy with the undertaking, but according to their own testimony they found no little difficulty in breaking the tendency to keep their classes together, and to conduct classes of bright and dull pupils in the same manner. Gradually differentiation of treatment has been attained, and skill in adjusting the work to differing aptitudes has been gained. The brighter groups will undoubtedly be able to do three years' work in two, while the duller ones will have gained a better mastery of the material than if they had been swallowed up in the ordinary mixed class. This attempt to employ mental tests in securing homogeneous groups of pupils is a significant step in educational procedure and the detailed reports of the results will be awaited with keen interest.

For the purpose of coöperating with various public schools in the use and interpretation of standard educational measurements, Dr. John W. Todd, of the departments of psychology and education in the University of North Dakota, has opened a bureau of educational measurements. The various tests are to be sent out to the schools that enroll in the bureau, used in the different grades, and then returned for tabulation.—*School and Society.*

At the University of Minnesota a short course for superintendents and principals will be held April 4 to 7 under the auspices of the State Department of Education and the College of Education. The special lecturers will be Dr. Leonard P. Ayres, Russell Sage Foundation, and Dr. Thomas D. Wood, professor of physical education in Teachers College.

Between March 16 and March 31 Professor C. E. Seashore of the University of Iowa will deliver a course of six lectures at the Harris Teachers College, St. Louis, Mo., on the subject "Vocational and Avocational Guidance in Music." The topics to be considered in the several lectures are (1) An inventory of the elements in musical talent, with illustrations of the method of charting measurements. (2) Tonal hearing and control of pitch, with methods of measuring the sense of pitch and the evaluation of ability in this respect for success in musical attainments. (3) Consonance and musical feeling. (4) The sense of time, rhythm and rhythmic action. (5) Musical memory, imagination and intellect. (6) A system for the survey of musical talent in the public schools.

The publishing house of Moffat, Yard and Company announces two series of forthcoming books under the general editorship of Dr. George Van Ness Dearborn. The first series will be entitled *The Life of the Child*, and will include works on the anthropology, anatomy, physiology, psychology, ethics, aesthetics, economics, mental defects, delinquency, happiness, hygiene, bodily defects, morbidity, and educational evolution of the child. The second series will be entitled *Our Senses*, and will include volumes on *Vision*, by Frank N. Spindler; *Hearing*, by Robert M. Ogden; *Taste*, by H. L. Hollingworth and Albert T. Poffenberger, Jr.; *Smell*, by Eleanor A. McC. Gamble; *Kinaesthesia*, by George V. N. Dearborn; *Pain and Pleasure*, by Henry T. Moore; *The Dermal Senses and General Sensations*, by Smith Ely Jelliffe; *Sensations of the Lower Animals and of Plants*, by Ada Watterson Yerkes and Robert M. Yerkes; and *Abnormal Sensations*, by Isador H. Coriat.

Professor H. G. Childs, of Indiana University, is spending the spring semester on leave of absence at Teachers College, Columbia University.

Owing to the death of Professor Münsterberg, several changes have been made in the courses for the second half year in psychology at Harvard University. Dr. Roswell Angier, assistant professor at Yale University, will conduct the seminar course. Assistant Professor Langfeld and Dr. L. T. Troland, of Harvard, will conduct the other courses in the department.—*School and Society.*

Professor Lewis M. Terman, of Leland Stanford Junior University, and Professor M. E. Haggerty, of the University of Minnesota, will give courses in mental tests and educational psychology at Teachers College, Columbia University, during the summer session.

Dr. Frederic Ernest Farrington has accepted the headmastership of the Chevy Chase School for girls at Washington, D. C.

Dr. Clayton C. Kohl, associate professor of secondary education in New York University, has been advanced to a full professorship in that institution.

Dr. John W. Withers, president of the William T. Harris Teachers College, of St. Louis, has been elected superintendent of the St. Louis schools to succeed the late Ben Blewett.—*School and Society.*

Dr. F. C. Ayer, professor of education in the University of Oregon, has been appointed professor of school administration in the State University of Iowa.

Mr. Dwight L. Hoopingarner, formerly tutor in educational psychology at the University of Texas, and more recently research fellow in the Bureau of Salesmanship Research, of the Carnegie Institute of Technology, has been appointed director of the division of employment and education in the National Bank of Commerce, New York City.

PUBLICATIONS RECEIVED

Annual Report of the Massachusetts Commission on Economy and Efficiency for 1915. Boston: State Printer, 1916. Pp. 304.

This report furnishes many illustrations of the saving that can be accomplished by a well organized efficiency commission. The danger is that the commission overlooks its function of helping on the work of the different departments and endeavors merely to save money. That way lies friction and inefficiency. In Massachusetts, fortunnately, the commission seems to interpret its function in the broadest and most helpful terms.

LEONARD P. AYRES. *School Organization and Administration.* Cleveland: The Survey Committee of the Cleveland Foundation, 1916. Pp. 135. Twenty-five cents.

Urges the Board of Education to define its functions and duties, to concern itself with getting things done and stop attempting to do so many of them itself, to place the responsibility upon the superintendent of schools for the conduct of the school system and to allow him a relatively free hand. It is of interest to note that the school board has since adopted these recommendations in their entirety.

LEONARD P. AYRES AND ADELE MCKINNIE. *The Public Library and the Public School.* Cleveland: The Survey Committee of the Cleveland Foundation, 1916. Pp. 93. Twenty-five cents.

The day of the single reading book has past. Both teachers and public are realizing that pupils must learn to read as they learn to talk,—through unremitting exercise. The survey recommends that school libraries be established in or near each new school building, that well equipped libraries and trained librarians be supplied for all junior high schools, that the salaries for school librarians be on a level with those paid teachers doing corresponding work, and that a corp of teacher librarians be organized under the direction of a supervisor of school libraries.

W. C. BAGLEY AND H. O. RUGG. *The Content of American History as Taught in the Seventh and Eighth Grades.* Bulletin No. 16, School of Education, University of Illinois, 1916. Pp. 59.

This monograph is based on an analytical study of the material contained in twenty-three elementary text-books in American history, published between the years 1865 and 1912. The delineation of the characteristics of these books is very interesting reading. The relative amount of space in each book devoted to each of nine periods of United States History is presented in tabular form. It is interesting to note that the space given to the Revolutionary War has steadily decreased, while that devoted to the National Period, 1783 to 1861, has steadily increased. The chief men and events have been

selected for each of these periods, and their relative importance is indicated in terms of the frequency of reference to them. Abraham Lincoln heads the list of those eminent in civil life, and when his frequency is set at 100, others have the following values: Washington 84, Jefferson 82, Jackson 49, John Adams 46, Madison 40, Hamilton 37, Henry Clay 33, J. Q. Adams 29, Monroe 23, Franklin 23, Patrick Henry 21, Van Buren, Calhoun, and Webster 20 each. The authors conclude that elementary American history is still predominantly political and military, although in recent years there is a tendency to stress economic and industrial development.

JAMES BALDWIN. *Fifty Famous Rides and Riders.* Cincinnati: The American Book Company, 1916. Pp. 303.

It may be a vestige of the primitive that still sways our moods, but the spirited account of a wild ride stirs the blood of even the most prosaic of us. Perhaps we have never backed a horse in our lives, but our imaginations suffice to conjure up the scene of the ride and to set our pulses tingling with the excitement of it. Here is a book that will interest both young and old. All the familiar favorites are here from John Gilpin onward, and many others that you never heard of. It is a splendid supplementary reading book.

FRANK W. BALLOU. *Penmanship. Determining the Achievement of Elementary School Graduates in Handwriting.* Boston: Bulletin No. IX of the Department of Educational Investigation and Measurement, Boston Public Schools, 1916. Pp. 43.

A test in copying was given to 4494 pupils in the first-year classes of fourteen Boston high schools. From these papers 600 were taken at random by selecting every eighth paper, divided into two groups of 300 each, and graded by three judges for each group. The basis of the grading was the Ayres scale for adult handwriting, using only the samples 10–30–50–70–90, and disregarding the even tens on the scale. Of the 600 specimens 8.5 per cent. received the rating of 90; 40 per cent., 70; 42.2 per cent., 50; and 9.3 per cent., 30. There were no ratings below 30. The bulletin contains an interesting discussion of the variations in the judgments, and a critical analysis of the merits and defects of the handwriting studied.

M. L. BEANBLOSSOM. *Mental Examination of Two Thousand Delinquent Boys and Young Men.* Jeffersonville, Indiana: Indiana Reformatory, 1916. Pp. 23.

No attempt was made to determine the "mental age" of the boys examined, but they were divided into ten groups (good, fair, and poor mentality, subnormal, moron, imbecile, specialized defective, dull from somatic causes, psychosis, and unclassified) on the basis of general considerations and previous history, and the results of certain Binet tests, general intelligence tests (cancellation, dot, motor

coördination, comprehension, inset board, instruction box, information, controlled association, and fidelity of report), and educational tests (Courtis arithmetic, Starch reading, and Trabue language). Tables show the distribution of the boys in these groups, correlations between various tests, norms from 200 inmates on certain tests, and results of the Kent-Rosanoff and the Binet tests. The report seems rather loosely thrown together, and of somewhat doubtful scientific worth. Perhaps those engaged in clinical work may find it of some practical value.

VIKTOR BLUETGEN. *Das Peterle von Nürnberg.* Edited by Frederick James Menger. Cincinnati: The American Book Company, 1916. Pp. 207.

A charming little story suitable for second year German.

ALICE C. BOUGHTON. *Household Arts and School Lunches.* Cleveland: The Survey Committee of the Cleveland Foundation, 1916. Pp. 170. Twenty-five cents.

The report discusses the development of household arts in elementary schools in the United States, infant hygiene, household arts in the high school and the organization and administration of the lunch service in both elementary and high school. Two types of organization are discussed, first, lunches furnished by concessionaires for their own profit; second, those provided by educational employees who aim to put the extra profit back into increased food and better service. The Cleveland system belongs in the first class. The survey recommends a change to the second type, centralization and consolidation, and supervision by an experienced dietitian.

W. E. CASTLE. *Genetics and Eugenics. A Text-book for Students of Biology and a Reference Book for Animal and Plant Breeders.* Cambridge: Harvard University Press, 1916. Pp. vi, 353.

This is a weighty book both literally and figuratively. It is printed on heavy glazed paper and is thus remarkably heavy for its size. In technical construction the book is admirable. The illustrations are so numerous as to be profuse and there are several plates printed in delicate colors. In content the book may be considered thoroughly reliable and authoritative. The author has attempted to present "in a form as simple and readily intelligible as possible the subject of heredity, as related to man and his creatures, the domestic animals and cultivated plants." Part I, Genetics, treats of such topics as Darwin's theories of evolution and pangenesis, the contributions of Lamarck, Weismann, and Herbert Spencer, the question as to the inheritance of acquired characters, biometry, the mutation theory, Mendel's law and the recent discoveries supporting it, the nature and presence of unit characters in common animals, sex-linked inheritance, sex determination, Galton's law of heredity and his principle of regression, inbreeding and crossbreeding. Part II, Eugenics,

deals with human crosses, physical and mental inheritance in man, the heredity of general mental ability, insanity, epilepsy and feeble-mindedness, and the possibility and prospects of breeding a better human race. The discussion is scientific but not too technical for an educated person to read and almost every chapter is replete with interest. Part II is naturally of the most significance for psychologists. The author does not find himself in great sympathy with those eugenic sociologists who believe that human mating should be controlled by the state. "As individuals primitive men were probably more than a match for us physically, and at least our equals mentally. As regards the standard of the individual, then, the race has not progressed. Civilization is a matter of collective achievement; it is not a biological inheritance at all, but a cultural one. Standing on the shoulders of the last generation we see farther because we are higher up, not because we are taller." The development of the argument is masterly and the book will undoubtedly take a high place in contributions to genetics. There is a carefully selected bibliography of twenty-five pages.

SARAH A. DYNES. *Socializing the Child. A Guide to the Teaching of History in the Primary Grades.* New York: Silver, Burdett and Company, 1916. Pp. x, 302.

In part one the author considers the theoretical basis of the value of history for the children of the first, second and third grades. She emphasizes the importance of a sympathetic relationship between teacher and child, the necessity for taking the child's experience as a point of departure in history study, of utilizing the child's communicative and dramatic impulses to make historical events vivid, and the function of the imagination in reconstructing the past. Part two gives detailed and specific recommendations for teaching history in the first three grades. Grade I centers about the relationships and activities of the family, Grade II is concerned with primitive man, the Eskimos and the Indians. Grade III outlines from the child's point of view life in Holland, Germany, Japan and France, and introduces the stories of Joseph, Ulysses, Alexander the Great and Columbus. This kind of study is vastly more educative than the grind of arithmetic and spelling which formerly burdened the children.

H. H. FICK. *Ich und Du.* Cincinnati: The American Book Company, 1916. Pp. 80.

This is a German reading book for children of the first grade. It is constructed with the wealth of illustration and excellence of workmanship which characterizes modern elementary reading books in English.

J. D. HEILMAN AND FRANK D. SHULTIS. *A Study in Addition.* Research Bulletin No. 1. Greeley, Colorado: State Teachers College, 1916. Pp. 16.

This is the type of study that we should see much more frequently coming from our normal and training schools. Twenty pupils were

chosen from the fifth and sixth grades, excluding those who knew all the addition combinations equally well, and those who were entirely ignorant of some of them. Each pupil was taken privately into a quiet room, the two numbers were presented orally, and the pupil called out their sum as quickly as possible. The time between the last number and the response was measured by a stop watch in fifths of a second, and was taken as a measure of the association. The following illustrate the results, representing extremes of readiness of association in fifths of a second: 7+9, 18.89; 9+7, 17.93; 6+9, 17.09; 8+6, 16.86; 5+8, 16.84; . . . 4+4, 6.47; 5+5, 6.43; 1+1, 6.08; 3+3, 6.03; 2+2, 5.72. It will be seen that 7+9 requires over three times as long as 2+2. Well-directed drill will reduce the association time on all these combinations to approximately one second.

RICHARD O. JOHNSON. *Analysis of Pupilage, Indiana State School for the Deaf.* Reprinted from the seventy-second annual report, September 30, 1915. Pp. 25.

In this report the author considers age-grade distribution, progress and retardation, degrees of deafness and retardation, and gives an account of the movement to establish intellectual norms for the deaf. It is probably the most detailed study of its kind that has ever been made, and promises well for a more intelligent and scientific treatment of the deaf.

RICHARD O. JOHNSON. *Outlines for the Guidance of All Connected with the Indiana State School for the Deaf.* Indianapolis: State School for the Deaf, 1916. Pp. 78.

This unique hand-book contains a brief history of the school, the calendar for work, notes on the course of study, the rules of the school, and a remarkably extensive and well-selected series of extracts from recent writings on experimental education. It is evident that the author believes it will do his teachers good to keep abreast of the experimental movement, and he proposes to encourage them in this endeavor.

EDITH KATHLEEN JONES. *Importance of Organized Libraries in Institutions.* Reprinted from the Proceedings of the Forty-third Annual Meeting of the National Conference of Charities and Corrections, No. 74, 1916.

Illustrates what may be accomplished by an institution library, and points out some of the pitfalls which are to be avoided in the conduct of such a library.

GEORGE ELLIS JONES. *Training in Education.* University of Pittsburgh Bulletin, Vol. 12, No. 17, July 15, 1916. Pp. 113.

This interesting monograph contains an introductory chapter on the basis of training, summarizing the most important contributions

to our knowledge of the modifiability of behavior, a discussion of the factors involved in training, and a description of typical school curricula based on activity. There is a bibliography of 120 numbers.

CHARLES HUBBARD JUDD AND SAMUEL CHESTER PARKER. *Problems Involved in Standardizing State Normal Schools.* Bulletin, 1916, No. 12. Washington: Bureau of Education, 1916. Pp. 141.

The introductory chapter on the scope of the bulletin gives a good summary of the various surveys and reports that have been recently made on normal schools, and indicates the sense in which the term standardization is used. Other chapters deal with the statistics of normal schools, practice-teaching facilities, faculties, courses of study, and a program for development of normal-school standards. In the latter section deserved emphasis is placed on productivity by members of the faculty. Every teacher in a normal school should be made to feel that the community expects him to do his part in widening the bounds of our knowledge as well as in teaching classes.

ISADORE KAYFETZ. *A Critical Study of the Harvard-Newton Composition Scales.* Reprinted from the Pedagogical Seminary, Vol. 23: 1916. 325–347.

The author thinks that it is a waste of time and energy to try to derive objective standards for the measurement of efficiency in composition, contends that we cannot judge a composition unless we know the writer's "age, grade, sex, nationality, general intelligence, school brightness, capacity for composition work, and social status," condemns dependence upon statistical treatment, and seems to consider it a heinous offense on the part of the author of these scales that he did not preface his work by an elaborate discussion of the standpoint of Meumann and Lay. Such criticism can scarcely be taken seriously.

ANTOINETTE KNOWLES. *Oral English, or the Art of Speaking.* New York: D. C. Heath and Company, 1916. Pp. vi, 361.

The need for better training in oral English is felt by high school teachers generally, and this feeling has given rise to a number of good text-books. The present text has many excellent features, such as suggestions for enlarging one's vocabulary and collecting choice expressions, planning a speech, oral rehearsals, the art of phrasing, how to use a library, the preparation of a brief, and introductions and conclusions. Each chapter is followed by a reading lesson illustrating the topic just discussed.

W. E. LARSON. *The Wisconsin County Training Schools for Teachers in Rural Schools.* Bulletin, 1916, No. 17. Washington: Bureau of Education, 1916. Pp. 40.

There are thirty county training schools in Wisconsin. This bulletin gives the law under which they are organized, outlines the course of study, presents an extended account of the work of the grad-

uates, and makes some suggestions for increasing the usefulness of these schools. On the whole they are rendering excellent service, and the plan is to be warmly commended to other states.

JAMES H. LEUBA. *The Belief in God and Immortality. A Psychological, Anthropological and Statistical Study.* Boston: Sherman, French and Company, 1916. Pp. xvii, 340. $2.00.

This is an extremely interesting book on an important aspect of social psychology. Part I presents two historical conceptions of immortality; the ghost idea and the idea of a land of immortality. The history of these two conceptions as manifested in human beliefs is traced in some detail. Part II contains a statistical study of the belief in a personal God and in personal immortality amongst American college professors and students. It is interesting to note that the proportion of those who believe in immortality decreases from the freshman to the senior year. A study of the returns from a questionnaire sent to a thousand American scientists shows that only about one-third of them believe in God, and a slightly higher number believe in immortality. Part III considers the social origin of moral ideas and inspiration, and the utility of the belief in God and in immortality. The material is well presented, the style is smooth and readable, and the subject matter of the discussion is fascinatingly interesting.

JACQUES LOEB. *The Organism as a Whole, from a Physico-chemical Viewpoint.* New York: G. P. Putman's Sons, 1916. Pp. x, 379. $2.50.

This book is intended as a companion volume to the writer's well-known *Comparative Physiology of the Brain.* The author tries to show that the unity of the organism is due to the fact that the egg is the future embryo, upon which the Mendelian factors in the chromosomes can impress only individual characteristics, probably by giving rise to special hormones and enzymes. This leads to the view that genus- and species-heredity are determined by the cytoplasm of the egg while the Mendelian hereditary characters scarcely contribute at all to the formation of new species. Of the fourteen chapters of which the book is composed the most interesting are perhaps those on regeneration, the mechanism of heredity, animal instincts and tropisms, and the influence of the environment upon the developing organism. The discussion presents many protests and arguments against the wide-spread conception of vitalism, and maintains throughout a mechanistic conception of life processes.

A. LAWRENCE LOWELL. *Liberty and Discipline: A Talk to Freshmen.* New Haven: Yale University Press, 1916. Pp. 16. Twenty-five cents.

In this address to the freshman class of Yale College the president of Harvard considers some aspects of American ideals suggested by

the present European conflict. The agencies of democratic civilization are now on trial. Whether they triumph or succumb depends upon the extent to which each individual voluntarily holds himself in subjection to the good of the group. It is a stirring appeal to the youth of the land to put lofty aims and high ideals above immediate satisfactions and petty jealousies.

JOHN T. MCMANIS. *Ella Flagg Young, and a Half-Century of the Chicago Public Schools.* Chicago: A. C. McClurg and Company, 1916. Pp. 238. $1.25.

In the present day when women are called upon more and more urgently to do their share of the world's work, and when the last barriers that have kept them from complete political, social, and economic equality with men are being broken down, it is fitting that we should have presented to us the life history of the woman who has attained to the highest administrative position in public school work that any woman has ever held. Mrs. Young's life is a story of steady, persistent, tenacious adherence to a purpose, to an ideal, to a lofty conception of service for the youth of the community in which she has lived. The book tells the story of her early life, of her training for teaching in the Chicago Normal School, of her work as teacher, principal, assistant superintendent, normal school principal, and superintendent of schools in the second largest city in the country. The conflict between politics and educational ideals in the conduct of the schools is clearly set forth, and while Mrs. Young was forced to give way to another administrative head, the account set forth in this book of the fight she waged with graft and political trickery will contribute materially to render such methods impossible in our schools.

WILLIAM MORRISON PATTERSON. *The Rhythm of Prose.* Columbia University Studies in English and Comparative Literature. New York: Lemcke and Buechner, 1916. Pp. xxiii, 193.

The sub-title of this monograph is "An Experimental Investigation of Individual Difference in the Sense of Rhythm." There is an interesting historical account of the work of Wundt's school, of American psychologists, and of Sievers and his school on the subject of researches in linguistics. The author then attacks the psychology of the sense of swing, and follows this with an examination of rhythmic tunes drawn from barbaric and poetic sources. In spite of the claims of Sievers and others, the author thinks that there is no scientific basis for the application of speech-melody to textual criticism. Three extended appendices contain a description of the apparatus used in the experiment, the experimental procedure, and the experimental data. There is a bibliography of eight pages.